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13. ABSTRACT (Maximum 200 words, 13 lines)

Asians and Middle Easterners participated in a virtual and real world environment to provide a unique perspective into deception and deception detection. Subjects physiology was measured as they navigated an airport scenario were one group engaged in deceptive behavior, while the control group did not. Law enforcement and military personnel participated as the security agents who attempted to identify the deceptive subjects through verbal questioning. The results provide a new insight into cultural influences on deception.

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Introduction

The objectives of the investigation were to examine how culture and personality influence deceptive behavior. Virtual reality technology has been used to simulate an interrogative situation that enables military and law enforcement personnel to better understand the strategy of deception and how it is affected by cultural and individual differences. Participants navigated a virtual airport scenario in which they must answer questions from a ticket agent and a security guard before boarding a plane (Figures 1a-1j). Some participants completed this activity with a 9mm Beretta concealed on their person (deception group); the rest of the participants did not have a small arm (control group). Both groups were monitored by non-invasive physiological means.

Fig. 1a

Fig. 1b

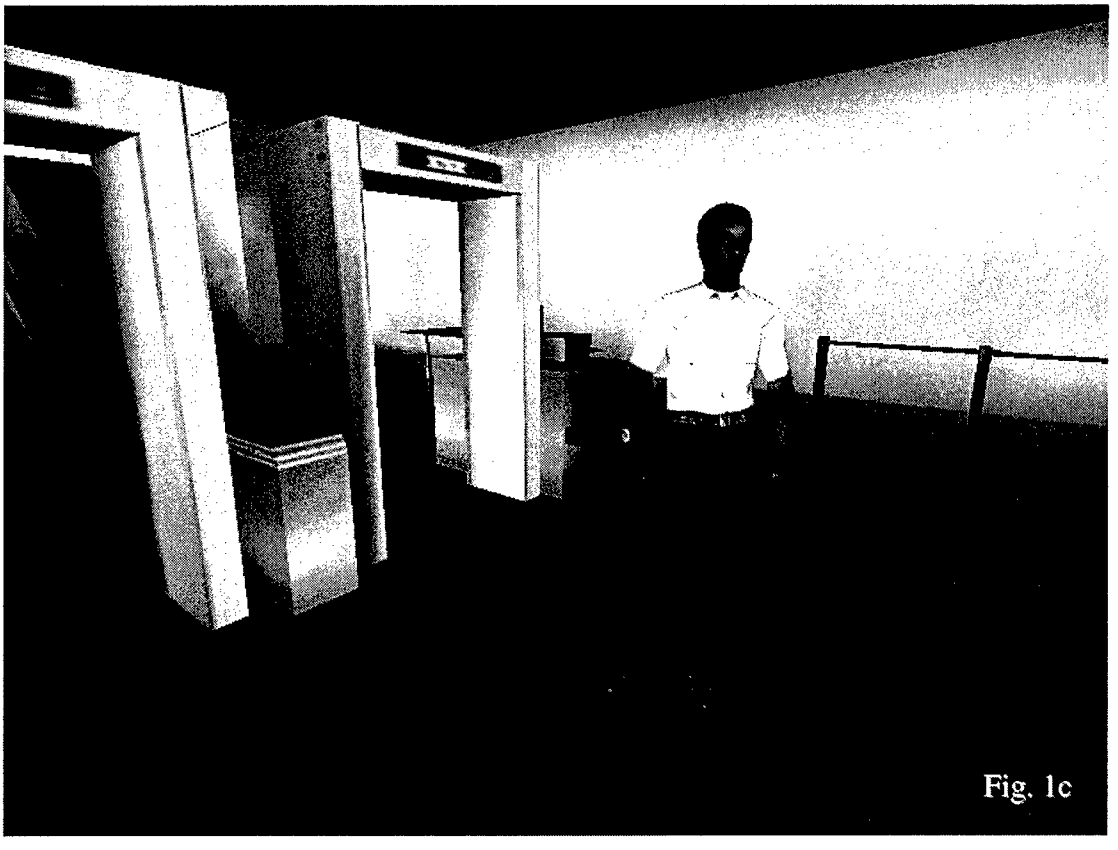

Fig. 1c

Fig. 1d

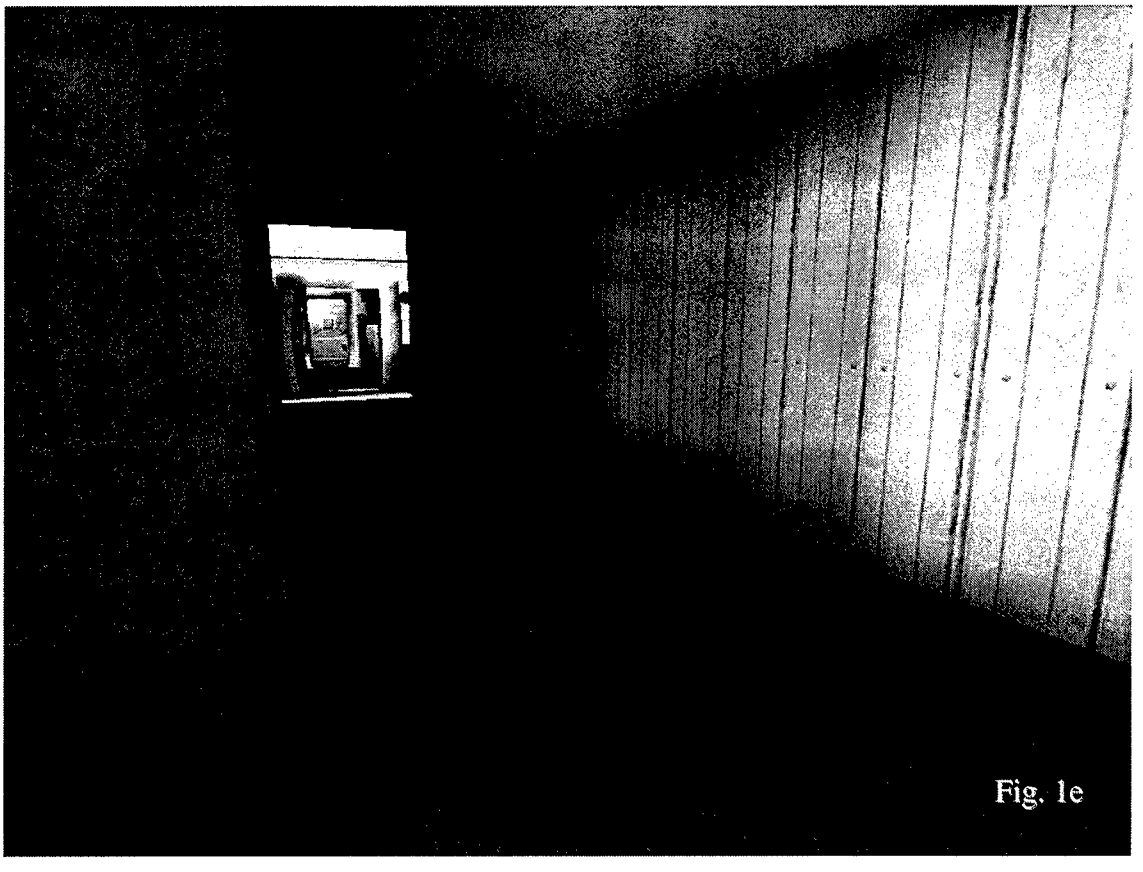

Fig. 1e

Fig. 1f

Fig. 1g

Fig. 1h

Real

Fig. 1i

Fig. 1j

Following the virtual task, all participants completed the same exercise in the "real-world" airport. The real-world airport is an exact replica of an airport terminal, complete with a ticket counter, security checkpoint with an x-ray machine, and an authentic fully-outfitted Boeing 727 A-200 aircraft (see Figures 2a, 2b, 2c, 2d and 2e). In this version, the interrogators (ticket agent and security agent) were military and law enforcement personnel who attempted to identify which individuals were carrying guns based on each participant's response to the questioning.

State-of-the-art graphic design and software technology have been used in the creation of the virtual world. Cutting-edge physiological monitoring technology has been developed to capture and interpret detailed patterns of physiology. The eventual result of our efforts will be an evocative tool that can be used to determine a specific, measurable reaction in participants based on their cultural and/or personality traits. From this, we can begin to make predictions about deception and deceptive responses based on cultural and individual factors.

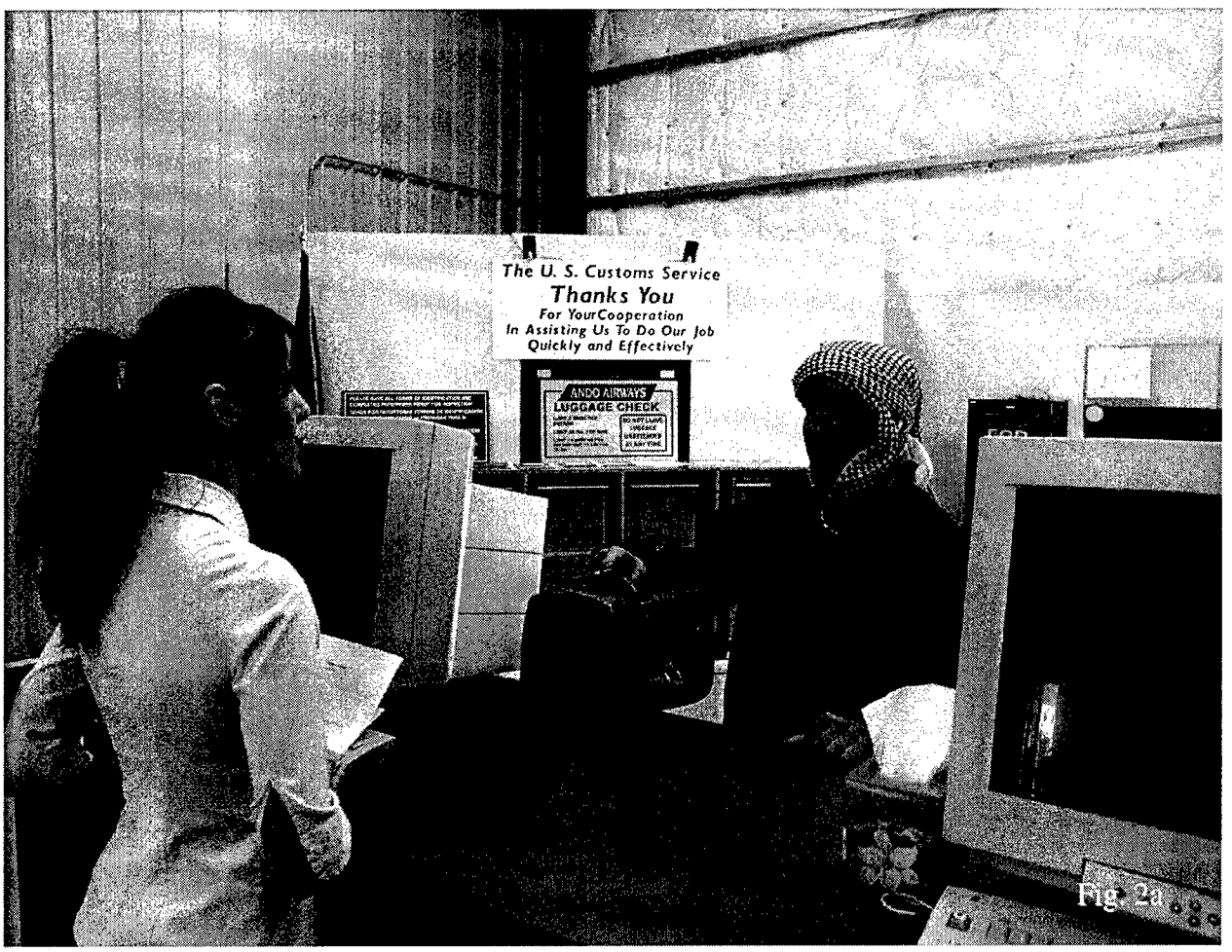

Fig. 2a

Fig. 2b

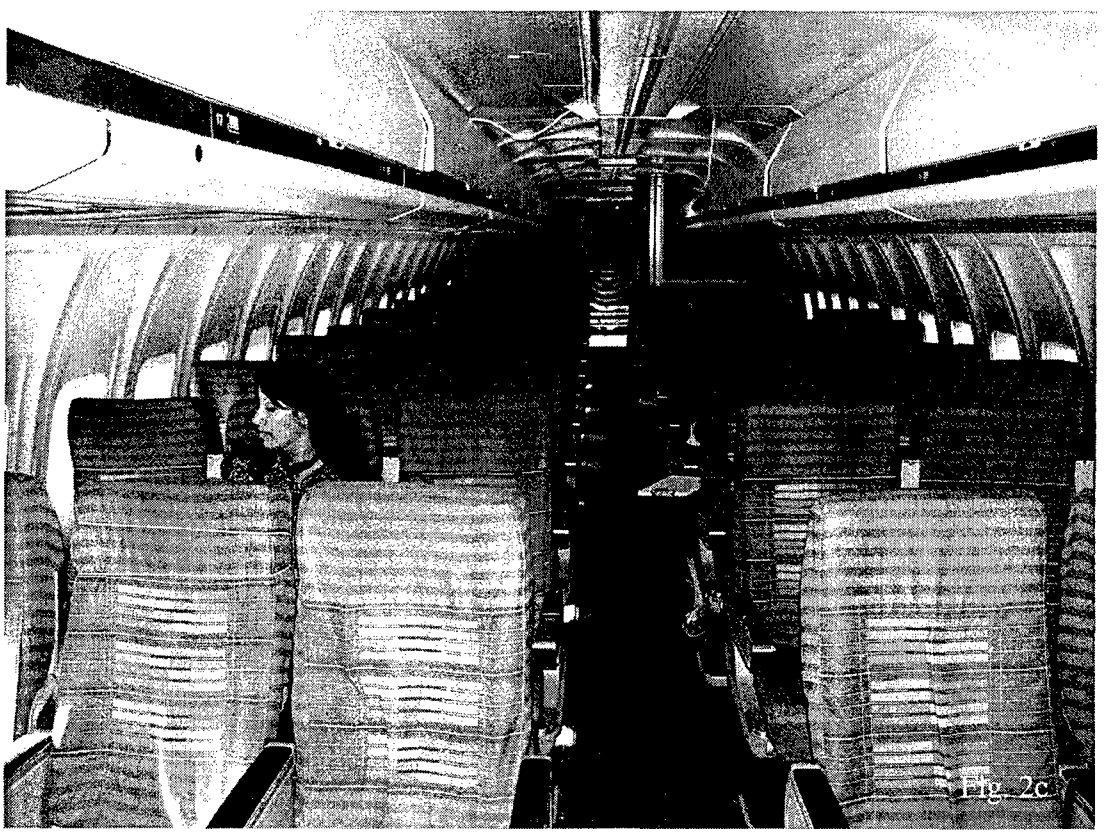
Fig. 2c

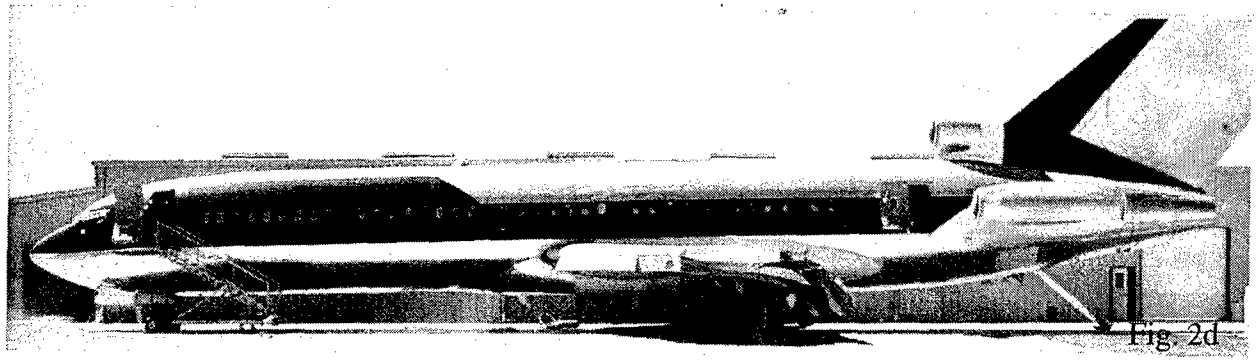

Fig. 2d

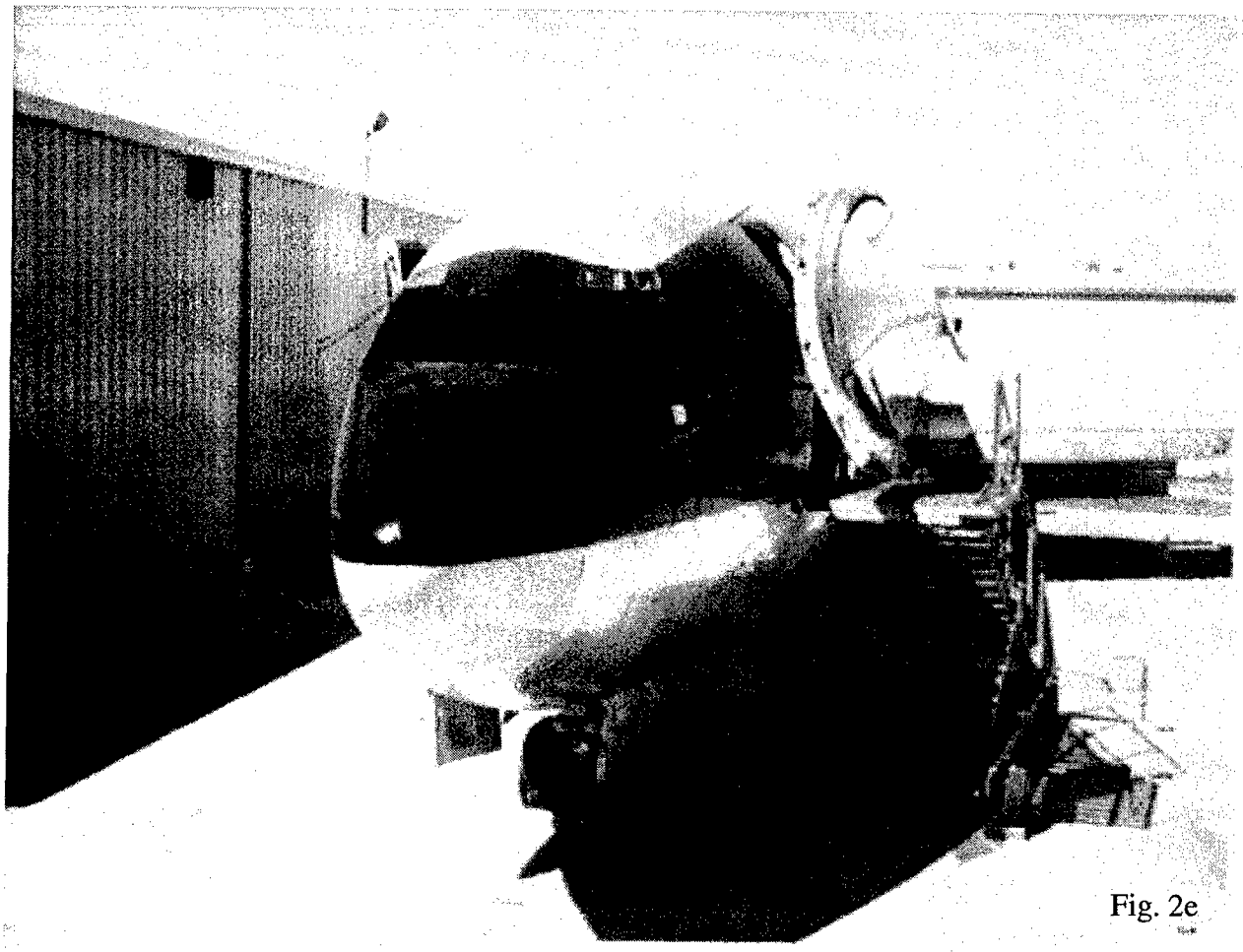

Fig. 2e

Methods

Participants

Participants included 46 volunteers recruited from the private practice of the Virtual Reality Medical Center (VRMC) and its consultant Strategic Operations. Of the participants, 21 identified themselves as Asian while 25 identified themselves as Middle Eastern. Demographics varied in gender, age, cultural identity, ethnic origins, religion, and length of time living in the U.S.

Apparatus and Task

Fig. 3

Participants navigated the virtual airport (Figure 3). They began outside the airport and were instructed to enter, locate, and engage in dialogue with the ticket agent and security personnel, then find their gate and board the plane. Participants were given an imaginary destination to help ease their interaction with the ticket agent. They were not given a time limit for this task, but were instructed to move as quickly as possible, trying to simulate real-life interaction.

The virtual airport was displayed using a Dell XPS laptop computer. Participants sat at a desk and used the keyboard and mouse to navigate the virtual airport.

The physiological measurements were collected using the J&J Engineering I-330-C2 system (Figures 4a, 4b). The EEG, ECG, galvanic skin response, temperature, and abdominal respiration sensors were used to collect data. Upon successful completion of the virtual airport, a Subjective Units of Distress Rating (SUDS) was recorded. Participants were asked to rate, on a scale of 0 to 100, how anxious they felt when they encountered the ticket agent, when they encountered security personnel, and when boarding the plane.

Fig. 4a

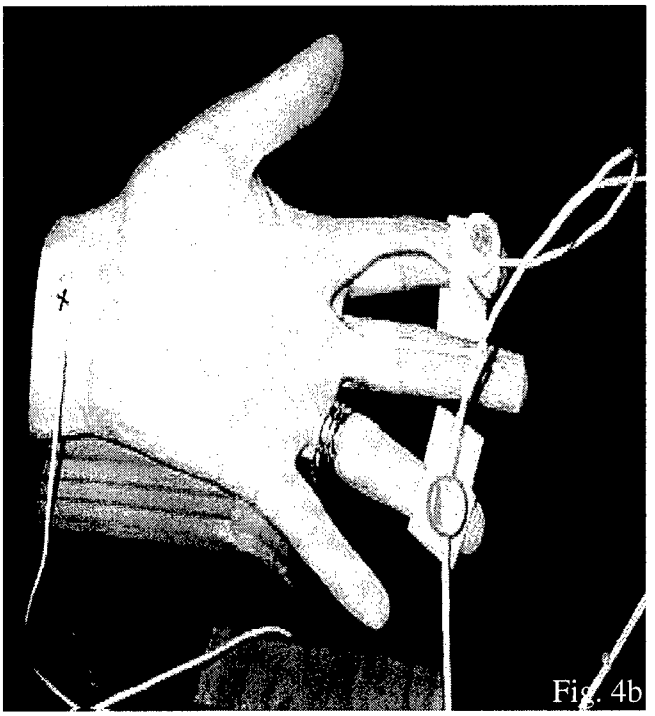

Fig. 4b

VR Training

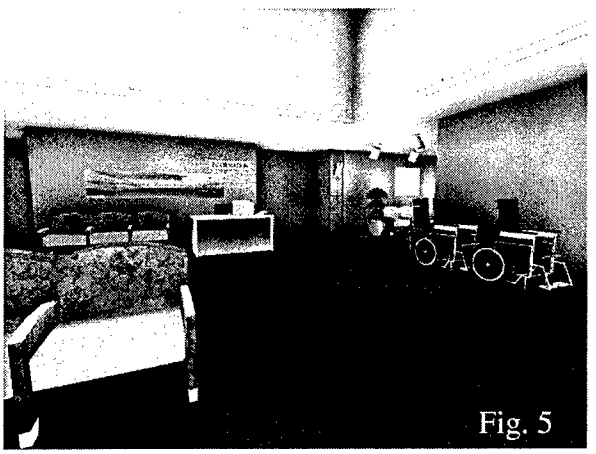

Fig. 5

Participants were exposed to virtual reality before entering the virtual airport. Participants were instructed and required to navigate through a virtual hospital for 3 minutes to become accustomed to the virtual environment (Figure 5). The investigators gave demonstrations on how to move through the virtual environment using the mouse and keyboard. After basic instructions, participants were asked to begin their tasks.

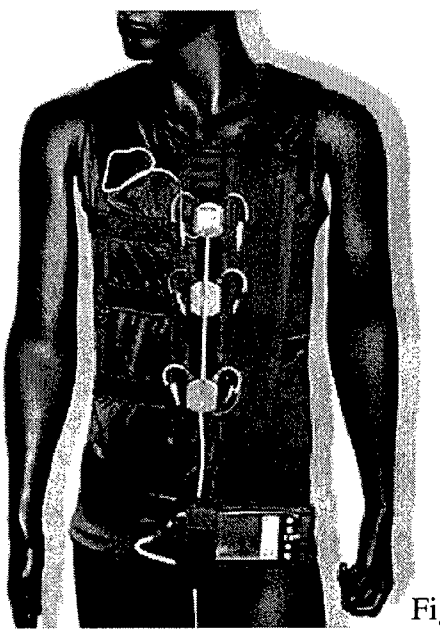

Fig. 6

Upon successful completion of the VR phase of the experiment, participants participated in the real-world airport simulation. Physiological measurements of the study participants and participants acting as security agents were collected using Vivometrics LifeShirts (Figure 6). The LifeShirt is a lightweight (8 oz.), machine washable, comfortable, easy-to-use shirt with embedded sensors. To measure respiratory function, sensors are woven into the shirt around the participant's chest and abdomen. A single-channel ECG measures heart rate, and a 3-axis accelerometer records participant posture and activity level. Peripheral devices measure blood pressure, blood oxygen saturation, EEG, skin temperature, end tidal carbon dioxide, and cough. The LifeShirt System includes an integrated PDA that continuously encrypts and stores the participant's physiologic data on a compact flash memory card.

In the real-world airport, participants started outside the airport and were instructed to enter, locate, and engage in dialogue with the ticket agent and security personnel, find their gate, board the plane, take their seats and sit for 5

minutes. Upon successful completion of the simulation, a SUDS rating was recorded and a semi-structured interview was conducted with the participant, ticketing agent, and security agent.

Design and Procedure

Participants were randomly assigned to the 2 groups via an online random number generator prior to their arrival at the test site. In the presence of Research Assistants, each participant completed the informed consent document.

Participants were then hooked to the J&J physiological monitoring system. Investigators explained the different physiological measurements to each participant. Participants sat quietly, relaxed, and with their eyes open while investigators recorded a 3-minute baseline measurement using the physiological sensors. A baseline SUDS rating was recorded at the end of the 3 minutes.

Participants were then given instructions on how to navigate the virtual world using the keyboard and mouse. After complete instructions were given, participants practiced for 3 minutes navigating through a virtual hospital to familiarize themselves with navigating a virtual world. Their physiological responses were recorded throughout the duration of this task. Participants were then given instructions for the virtual airport. The instructions were to locate the ticket agent and engage in dialogue (participants were given a destination to make for a smoother interaction), proceed to security, and answer questions, find their gate, and board the plane. Participants navigated the virtual world until all tasks were successfully completed. A SUDS rating was recorded for interaction with the ticket agent, security agent, and boarding the plane. This point marks the end of the virtual reality phase of the experiment.

Participants were then escorted to the wardrobe room where they donned the Vivometrics LifeShirt and garb that most accurately resembled their ethnic background based on the Subject Questionnaire. For example, the female depicted below (Figure 7) identified herself as a traditional Shiite Muslim from Iran.

She wears the black abaya with a 2-piece head cover and veil, which is common amongst Shiite Muslim females.

At this point, if the participant was assigned to the deception group they were issued a 9mm Beretta. The small arm was placed in a shoulder holster and obscured by the outer garment. A sitting baseline was recorded for 2 minutes. The small arm was issued, and a standing baseline was recorded for 2 minutes.

A 2-minute sitting and standing baseline was recorded for participants in the control group. Participants in both groups were given the same travel destination, no check-in luggage, and 1 carryon bag. They were instructed to act as normal as possible, and once on the plane, to sit in their seat for 5 minutes.

In a separate room the security agent and ticketing agent were being briefed. The ticketing agent did not wear any physiological devices and was given a script to repeat verbatim to the participant. She also escorted the participant from the security checkpoint to the plane (Figures 8a, 8b). The security agent wore the LifeShirt and a regulation San Diego Police Department uniform complete with badge and sidearm (Figure 9). He was allowed and encouraged to have a dynamic and fluid dialog with the participant. The only restrictions were to keep the questioning below 2 minutes and to let everyone board the plane.

Fig. 8a

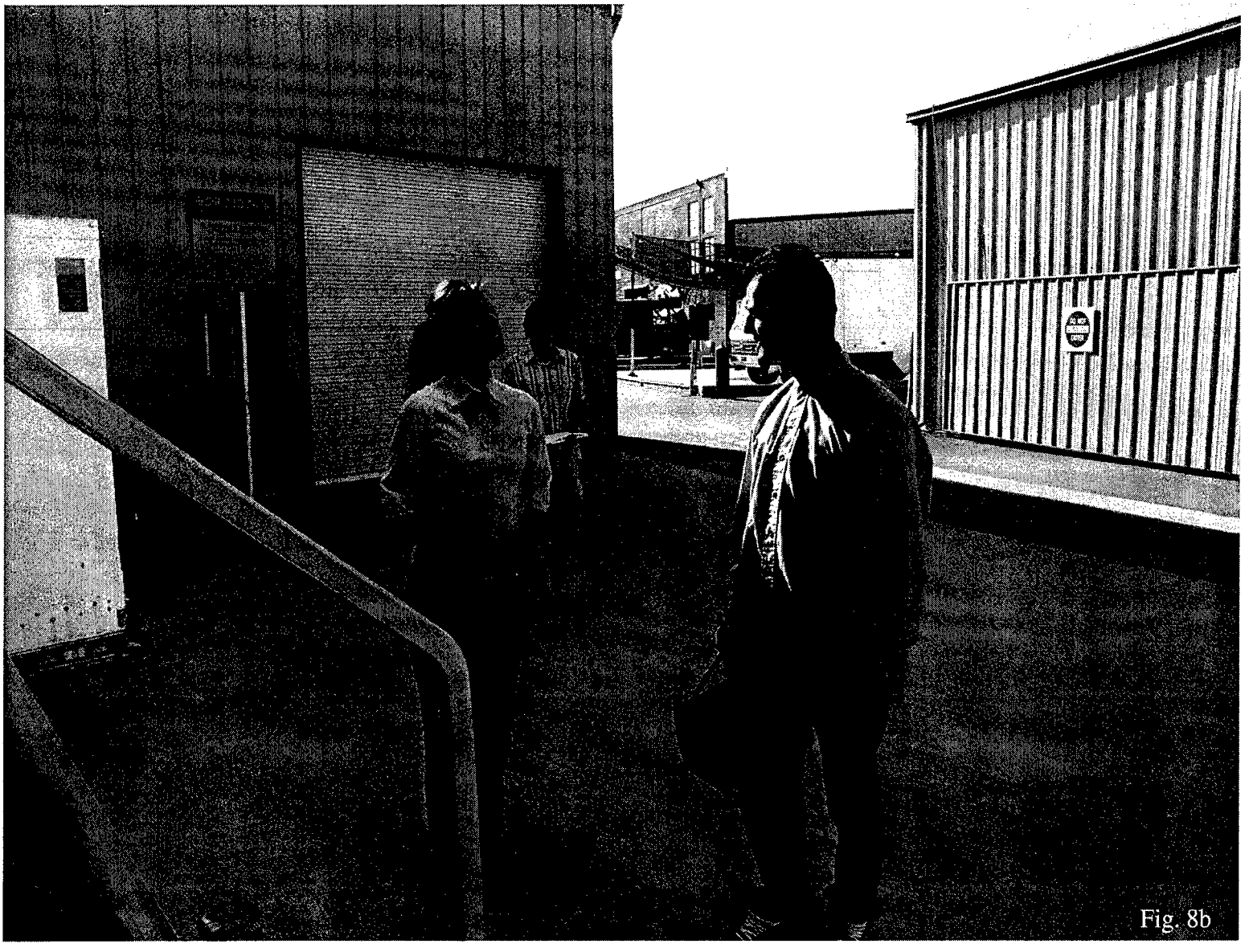

Fig. 8b

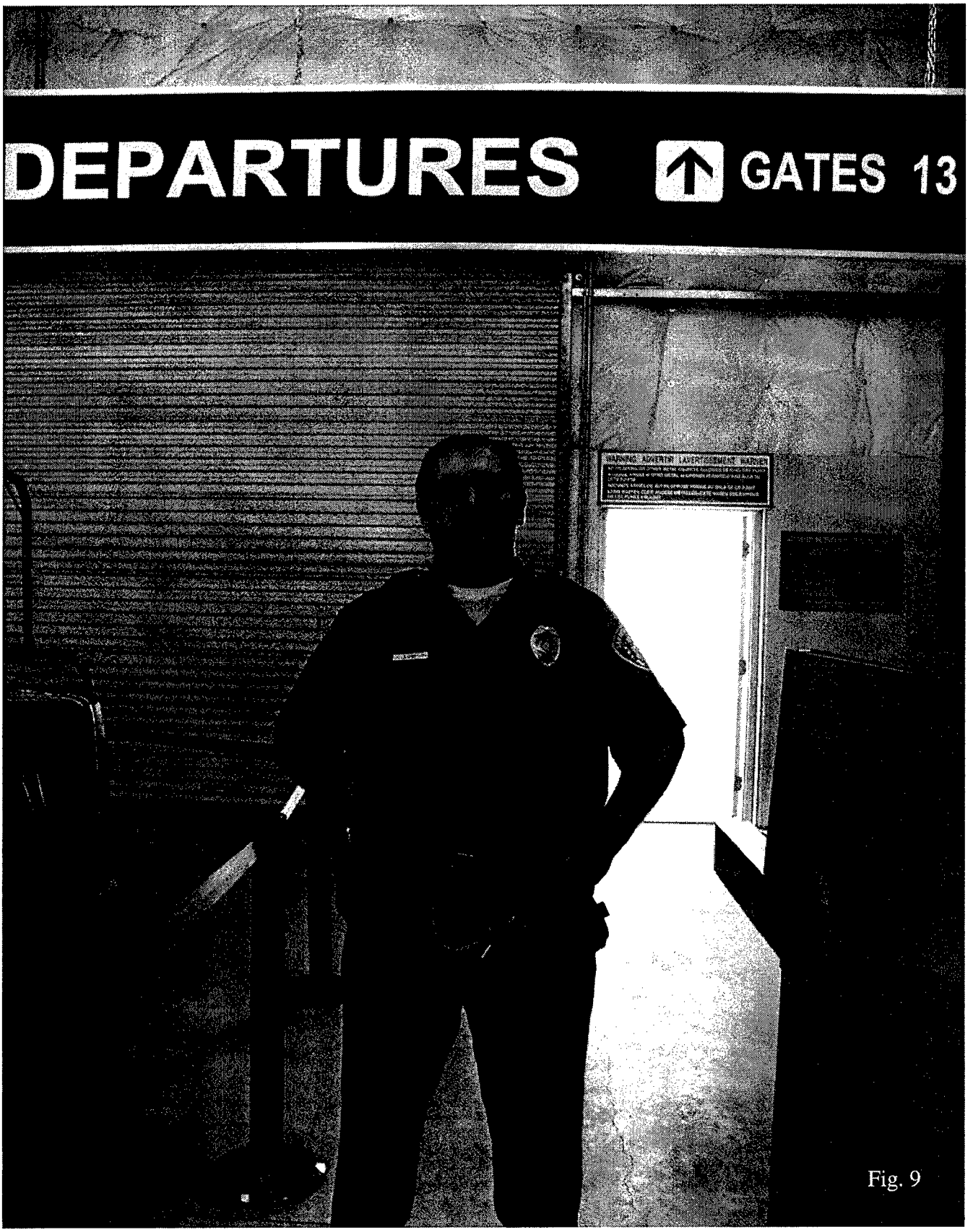

Fig. 9

Once participants entered the airport, Research Assistants logged the time and behavior of participants as they progressed through the airport and onto the airplane. Another Research Assistant was assigned exclusively to the security agent. Behaviors, facial expressions, and body language of both the participant and security agent were strictly observed and noted. Additionally, there was a digital camera strategically placed to record the participant's face while interacting with the security agent. Furthermore, there was another camera placed on the airplane to record the participant's movements and actions once on the plane and in the seat.

Accomplishments to Date

The virtual and real airport have been constructed and completed. Subjects have been run and data have been analyzed.

Difficulties Encountered

Construction and scheduling of the real airport.

Comparison to Plan

- Status achieved is consistent with planned goals for design of the virtual and real environment, subject recruitment, and resources expended are also consistent with projected amounts.
- Milestone/Task Status
  Each milestone:
  - Effort expended on the task to date includes 511 hours of design and preparation by Software Engineers in developing the virtual world. They have also tested the software for operational compatibility and verified that it is in reliable working order. Graphic artists have spent 1049 hours capturing and modifying images, and creating the virtual world. Research Coordinators have spent 653 hours recruiting and testing participants and completing all governmental requirements necessary for human subject research. Statisticians have spent 155 hours conducting multi-dimensional analyses.

Results

VR vs. Live Simulation

Similarities

Temperature measurements suggested that Asians became more anxious in the airport than Middle Easterners in both the VR (Figure 10) and live simulation (Figure 11).

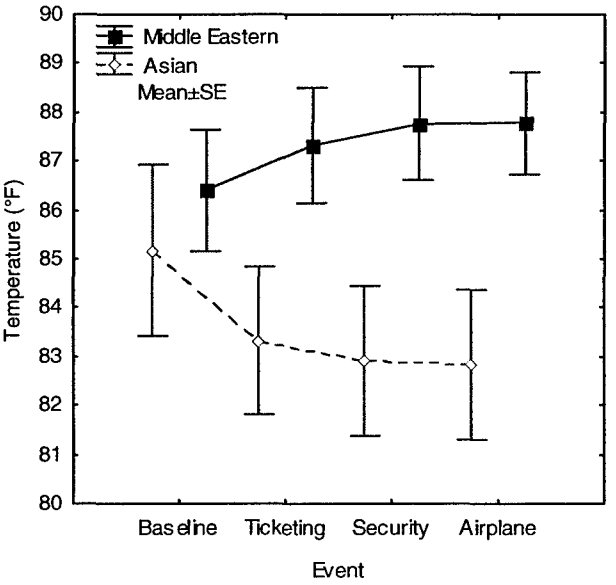

Figure 10. In the VR airport, Asians experienced a greater decrease in skin temperature than Middle Easterners (repeated measures ANOVA; df = 3, 93; $p < 0.001$). This suggests that Asians had greater anxiety when navigating the virtual airport.

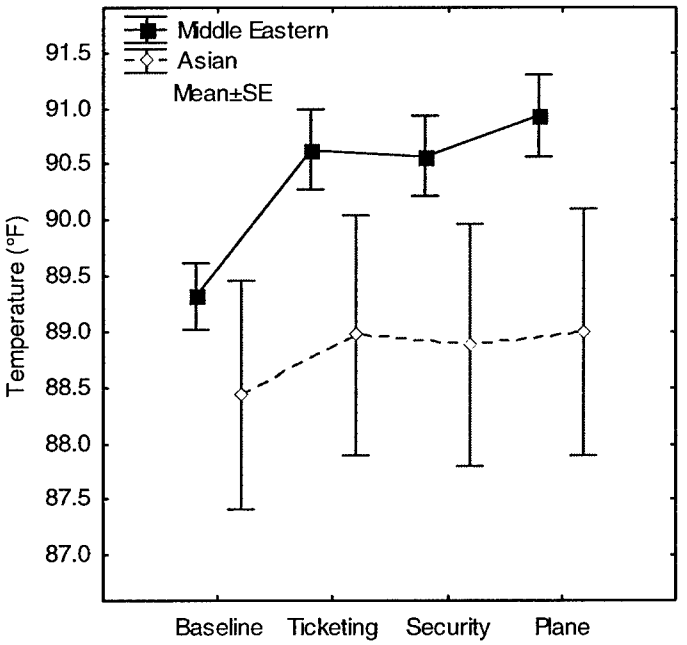

Figure 11. In the live simulation, Middle Easterners experienced a greater increase in skin temperature than Asians (repeated measures ANOVA; df =3, 93; $p < 0.001$). This suggests that Middle Easterners were less anxious during the airport simulation

There were some indications of increased anxiety in both VR and live simulations.

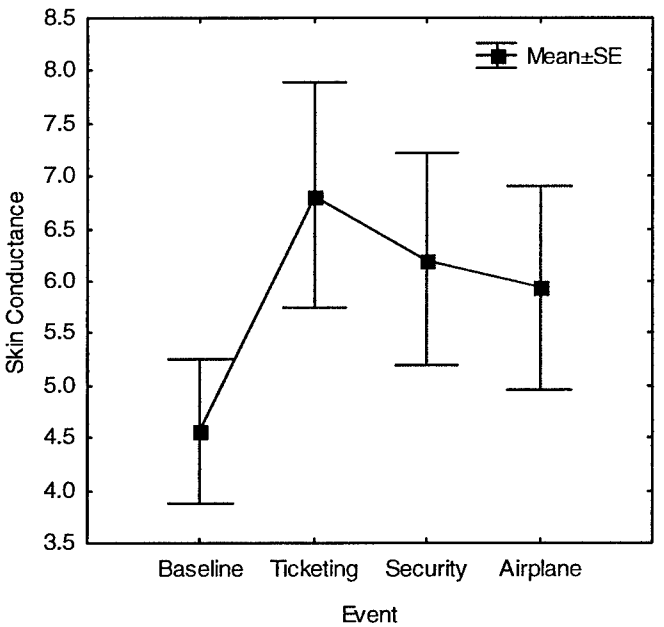

Figure 12. Skin conductance increased from baseline in VR (repeated measures ANOVA; df = 3, 60; $p < 0.001$). This suggests that participants became more anxious upon entering the virtual airport.

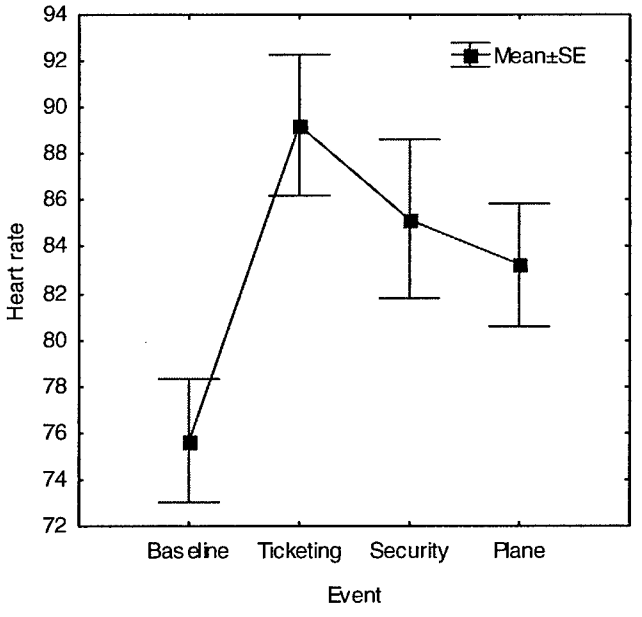

Figure 13. Heart rate increased from baseline in the live airport simulation (repeated measures ANOVA; df = 3, 72; $p < 0.001$). This suggests that participants became more anxious upon beginning the airport simulation.

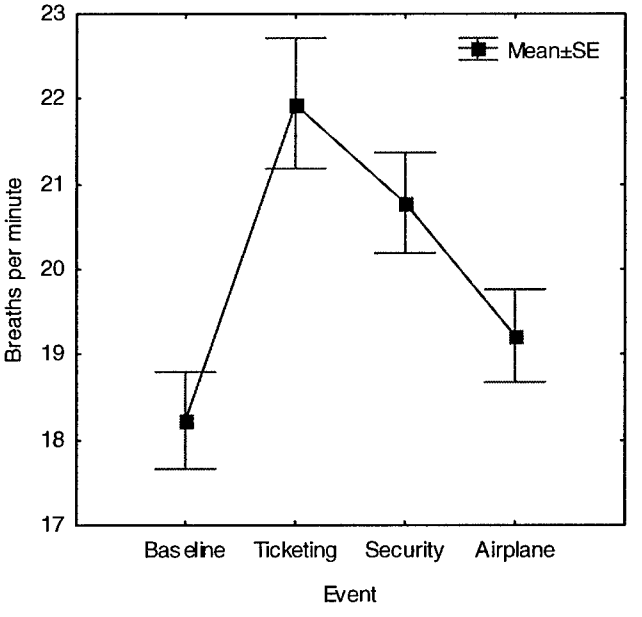

Figure 14. Breathing rate also increased from baseline in the live simulation (repeated measures ANOVA; df = 3, 72; $p < 0.001$). This suggests that participants became more anxious upon beginning the airport simulation.

Differences

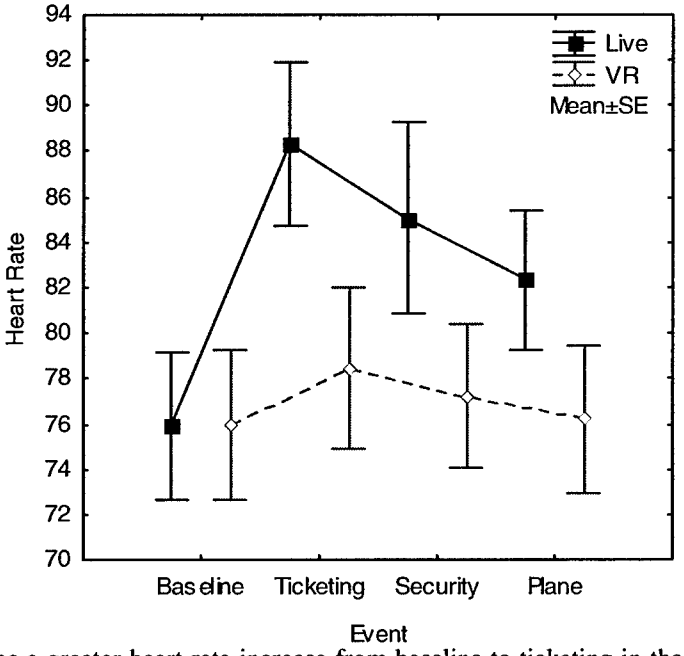

Figure 15. There was a greater heart rate increase from baseline to ticketing in the live simulation than in the VR simulation (repeated measures ANOVA; df = 3, 54; $p < 0.001$). This suggests that the live airport simulation evoked more anxiety than the virtual airport.

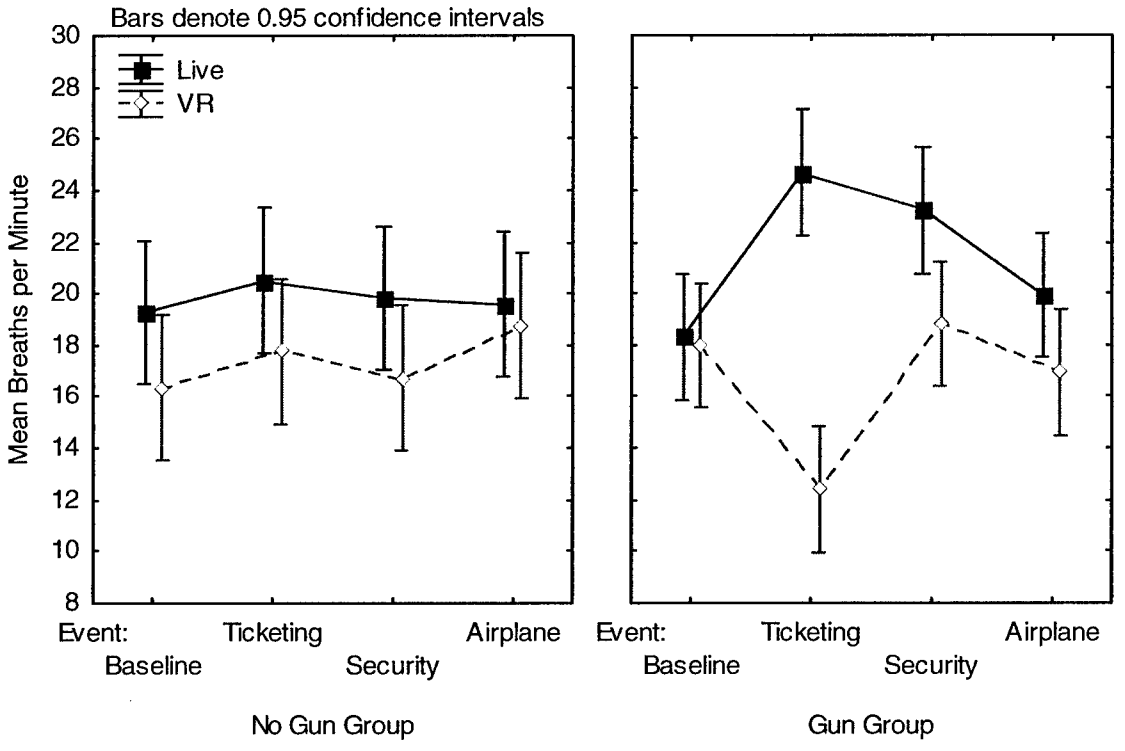

Figure 16. Participants in the "no gun" group had no breathing rate differences between VR and the live simulation. However, participants in the "gun" group had an increase in breathing rates from baseline in the live simulation and a decrease in the VR (repeated measures ANOVA; df = 3, 36; p = 0.013). This suggests that when people did not have a gun in the live trial, their response was similar to the VR trial, but when they did have a gun, they were more anxious in the live airport than in the virtual airport.

Cultural Differences

Asians vs. Middle Easterners

Temperature suggested that Asians became more anxious in the airport than Middle Easterners in both the VR and the live simulation (Figure 10).

VR Differences

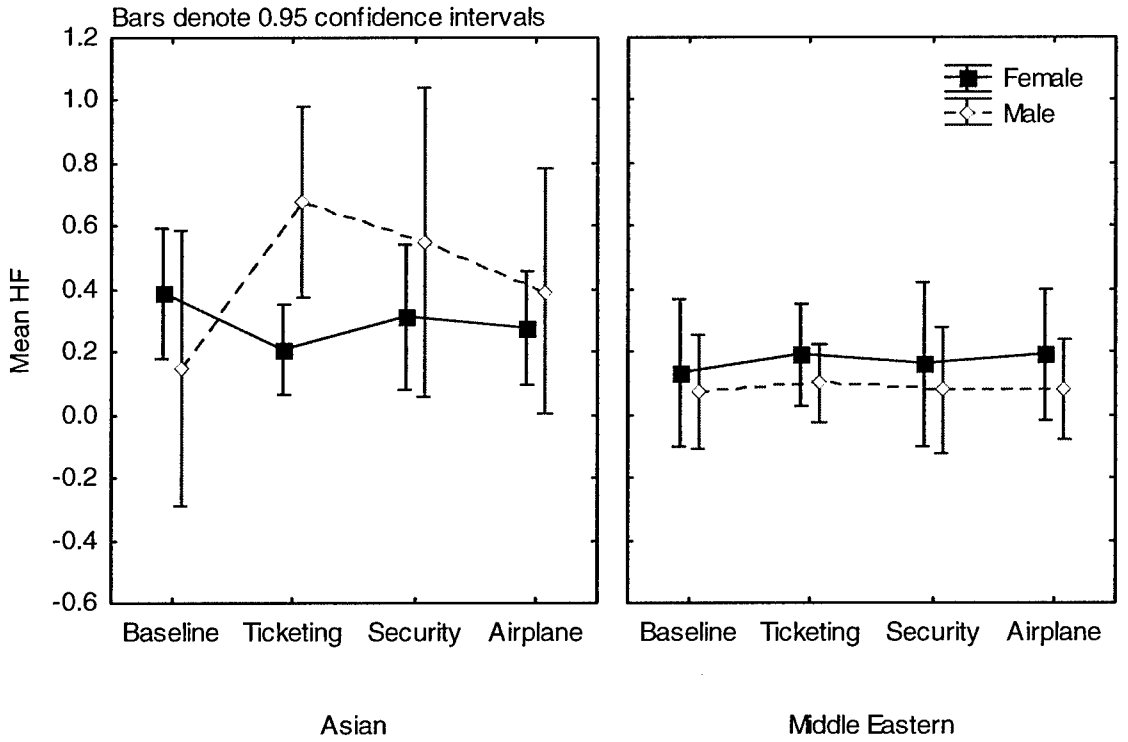

Figure 17. In the VR, Asian males had increased high frequency component of heart rate variability (HF) in the airport, while Asian females did not. However, both male and female Middle Easterners showed no significant HF change in the airport (repeated measures ANOVA; df = 3,78; $p < 0.001$).

Live Simulation Differences

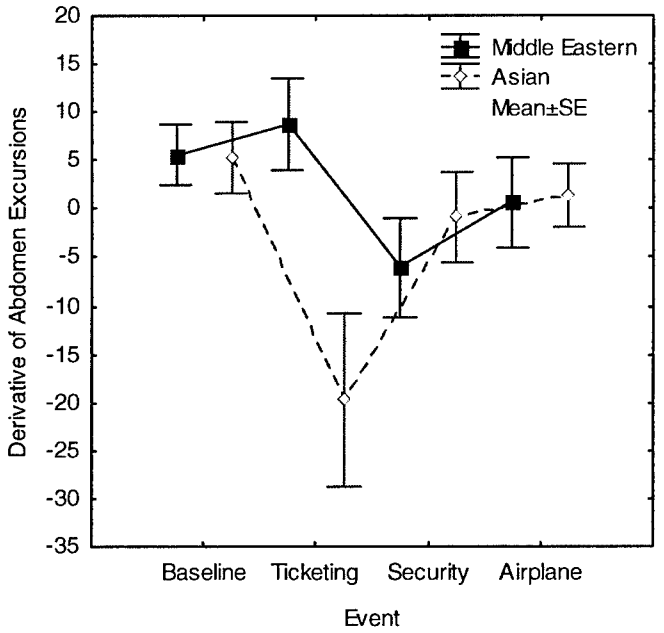

Figure 18. In the live simulation, Asians had a significant decrease in the derivative of abdomen excursions upon entering the airport. Middle Easterners did not have a decrease until security (repeated measures ANOVA; df = 3, 93; p = 0.031).

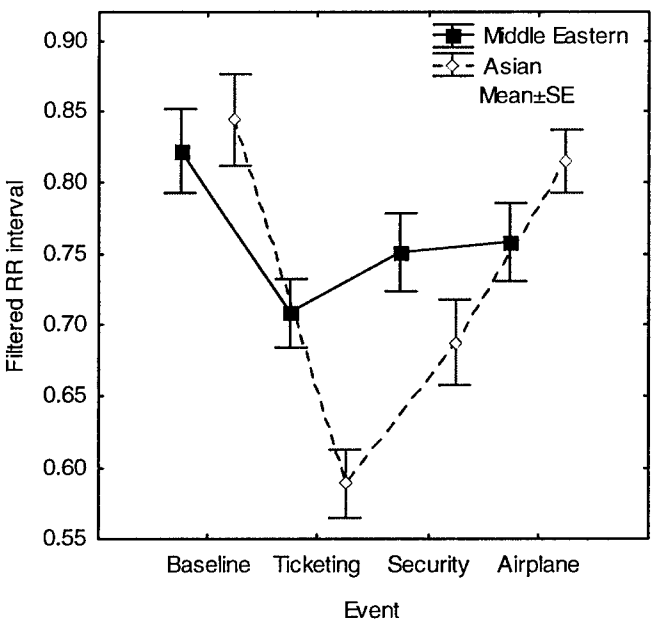

Figure 19. Upon entering the airport, Asians had a larger drop in filtered RR interval than Middle Easterners (repeated measures ANOVA; df = 3, 93; p < 0.001). This suggests that Asians became more anxious upon entering the airport.

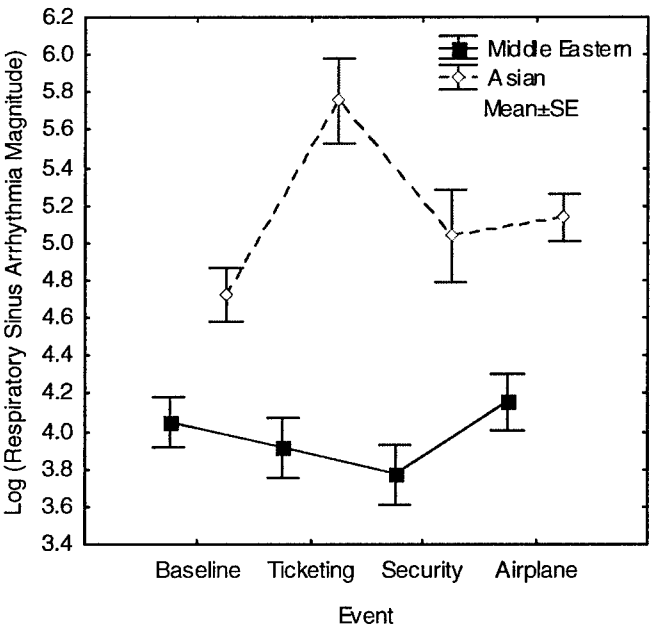

Figure 20. After log transformation, Asians also had a larger increase in respiratory sinus arrhythmia magnitude in the airport than Middle Easterners (repeated measures ANOVA; df = 3, 93; p < 0.001).

Iraqis vs. Iranians

VR Differences

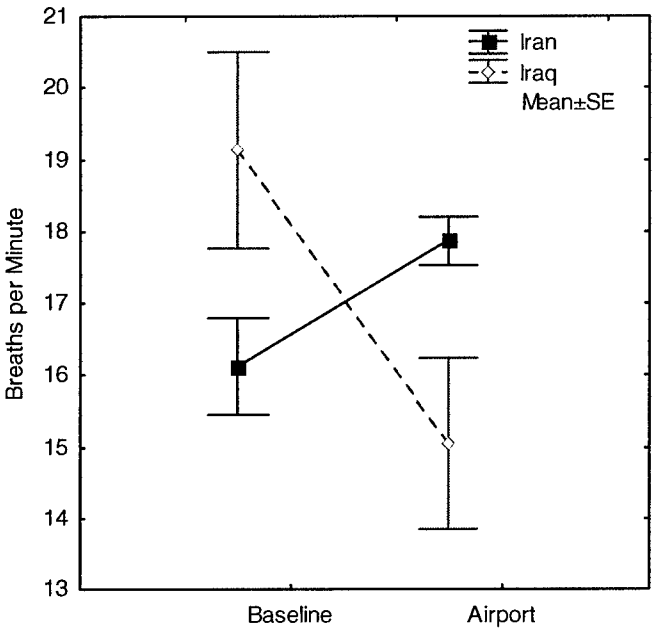

Figure 21. In the airport, Iraqis had a decrease in breathing rate, while Iranians had an increase (repeated measures ANOVA; df = 1, 12; p = 0.011). This suggests that Iraqis became more relaxed in the virtual airport, while Iranians became more anxious.

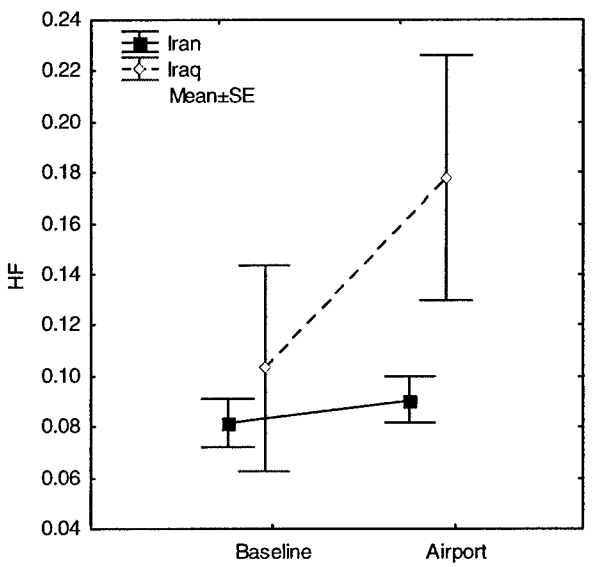

Figure 22. Iraqis had a larger HF increase from baseline to VR airport than Iranians (repeated measures ANOVA; df = 1, 13; p = 0.050).

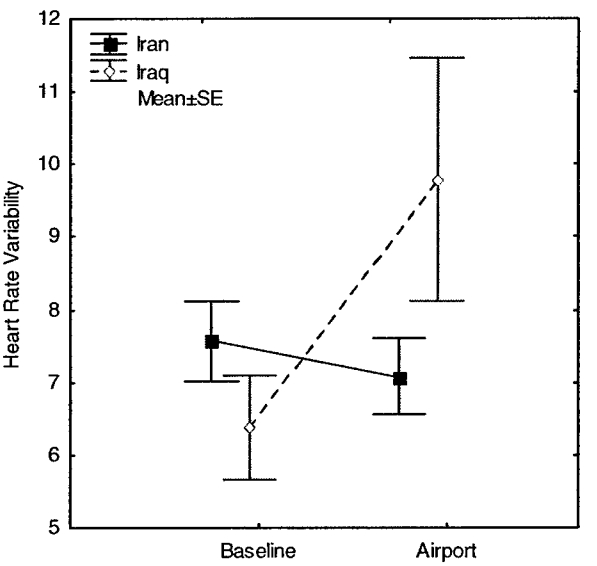

Figure 23. Iraqis had a larger heart rate variability increase from baseline to VR airport than Iranians (repeated measures ANOVA; df= 1, 13; p = 0.030).

Live Simulation Differences

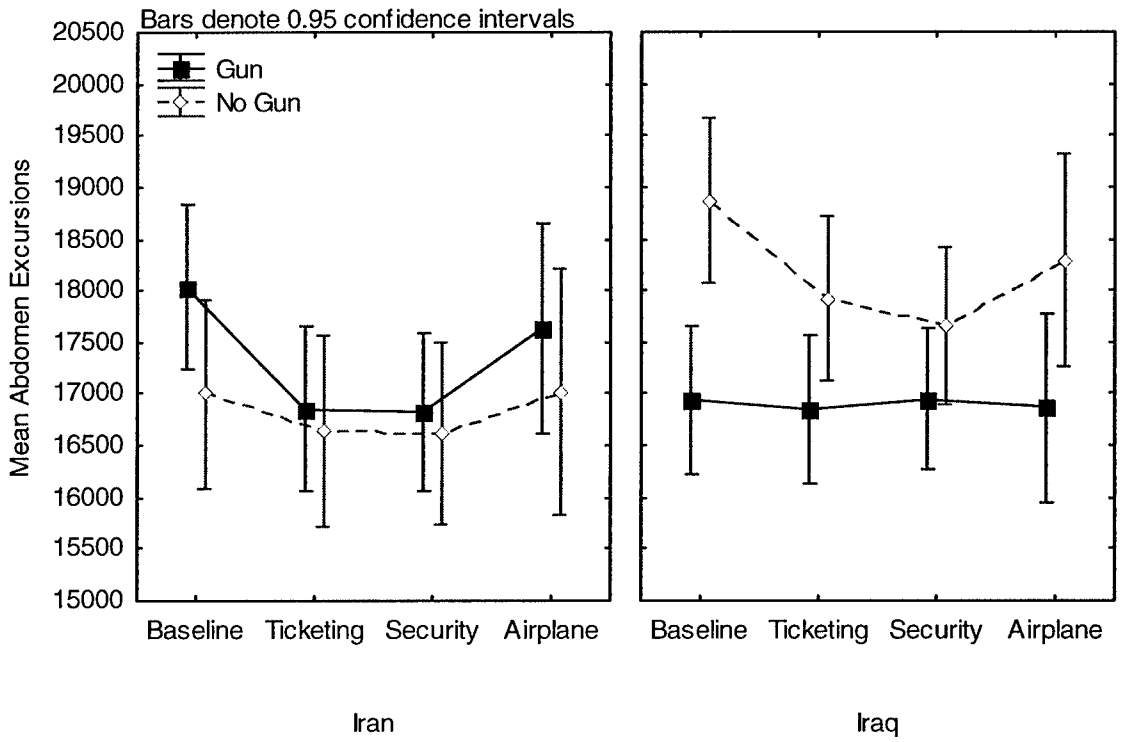

Figure 24. Iraqis had a larger decrease in abdomen excursions after baseline when they did not have a gun, while Iranians had a larger decrease after baseline when they did have a gun (repeated measures ANOVA; df = 3, 36; p = 0.044).

Middle Eastern vs. Western Clothing

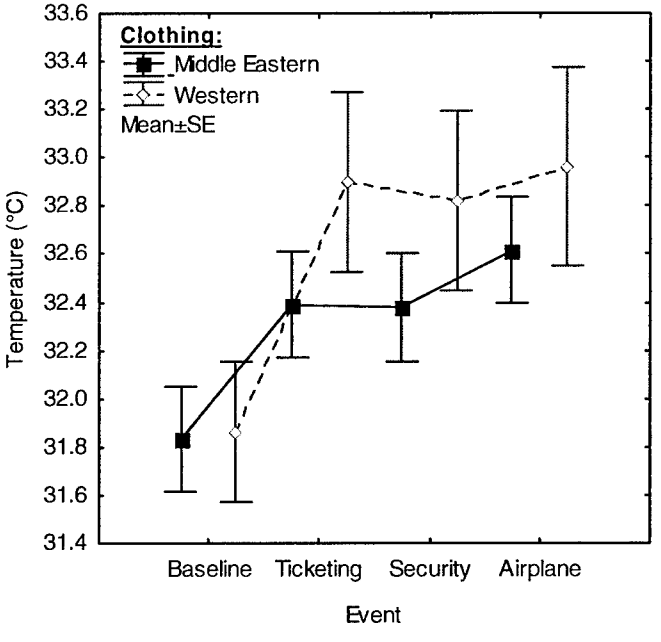

Figure 25. Participants in Western clothing had larger temperature increases from baseline than participants in Middle Eastern clothing (repeated measures ANOVA; df = 3, 69; p = 0.007). This suggests that participants in Middle Eastern garb were less relaxed when starting the live airport simulation.

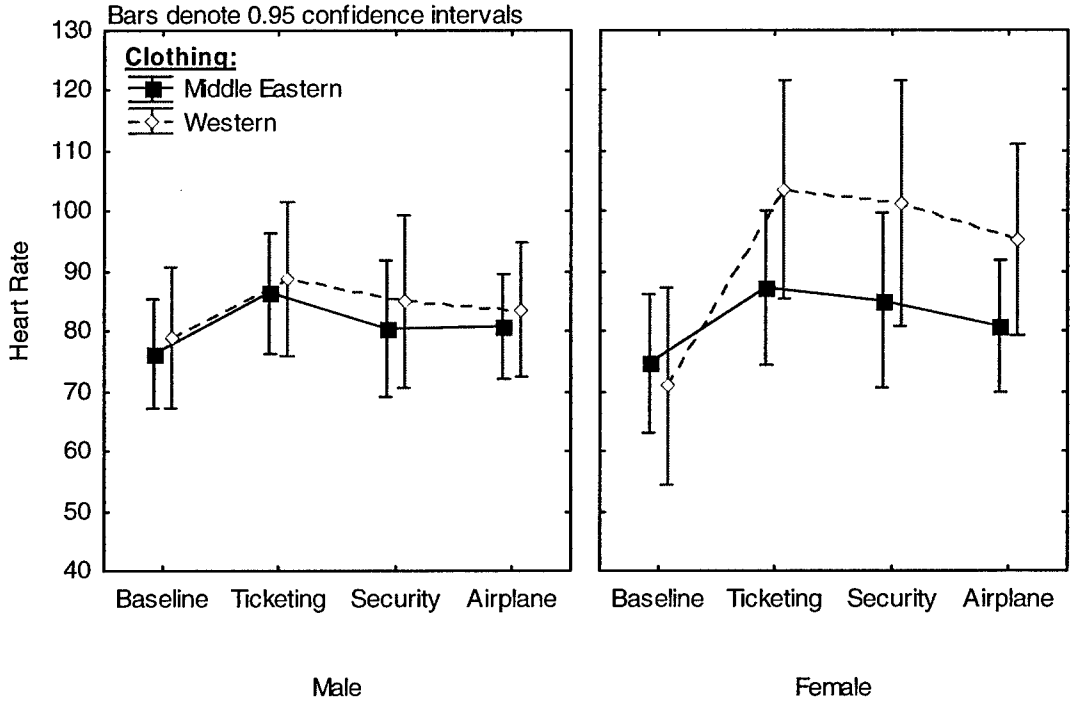

Figure 26. Men's heart rates did not vary with clothing, but women dressed in Western attire had larger heart rate increases in the airport than women dressed in Middle Eastern clothing (repeated measures ANOVA; df = 3, 63; p = 0.010). This suggests that men did not react differently to the two clothing types, but women were more anxious when wearing Western clothes.

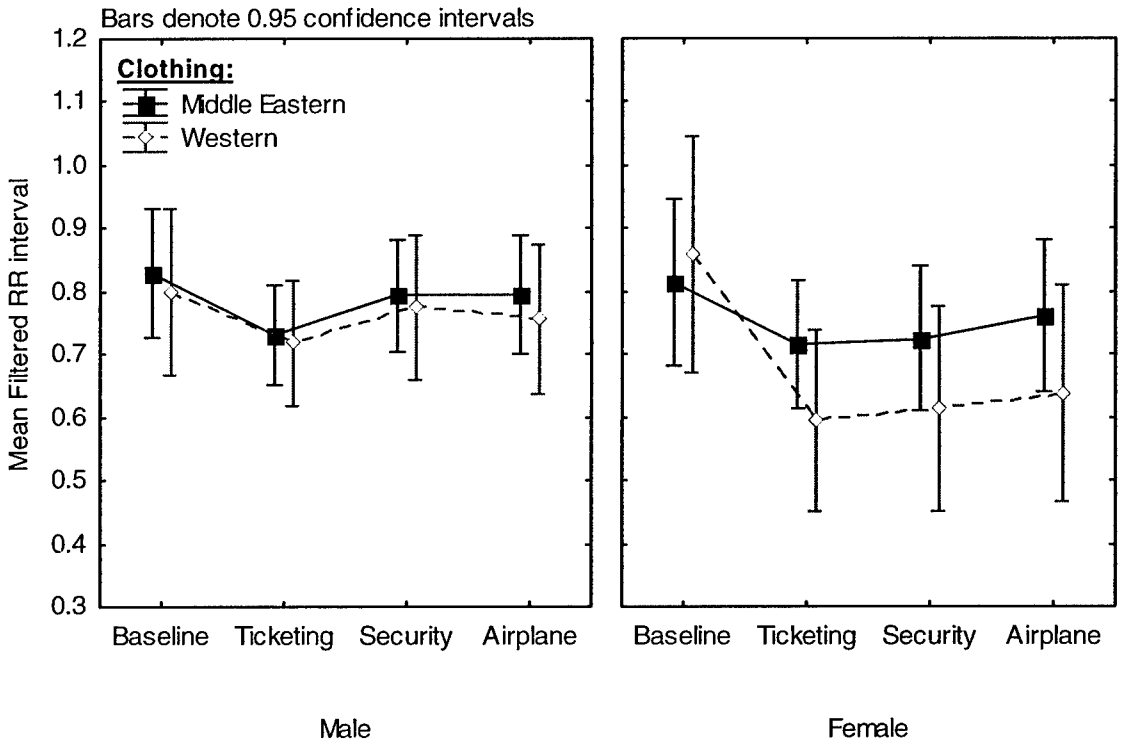

Figure 27. Men's filtered RR intervals did not vary with clothing, but women dressed in Western attire had larger decreases in the airport than women dressed in Middle Eastern clothing (repeated measures ANOVA; df = 3, 63; p = 0.030). This agrees with the heart rate results in Figure 26. This suggests that men did not react differently to the two clothing types, but women were more anxious when wearing Western clothes.

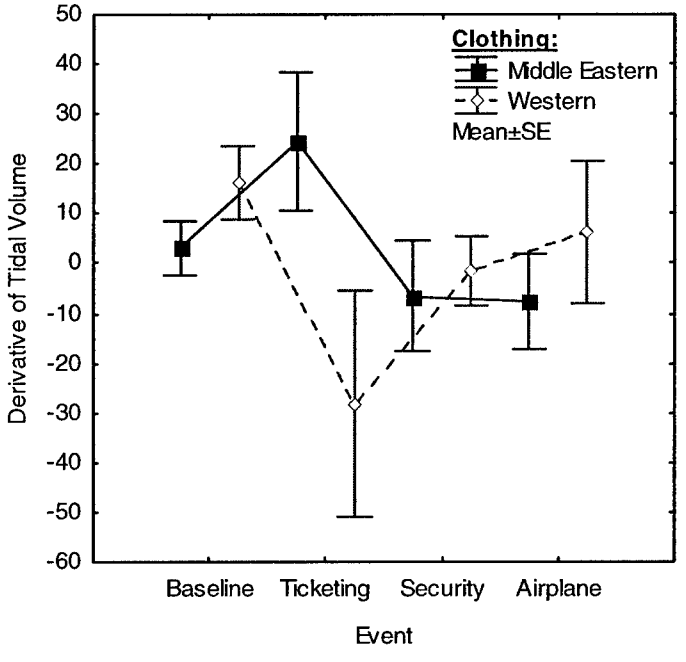

Figure 28. At ticketing, participants in Middle Eastern clothing had an increase in the derivative of tidal volume, while participants in Western clothing had a decrease (repeated measures ANOVA; df = 3, 69; p = 0.025).

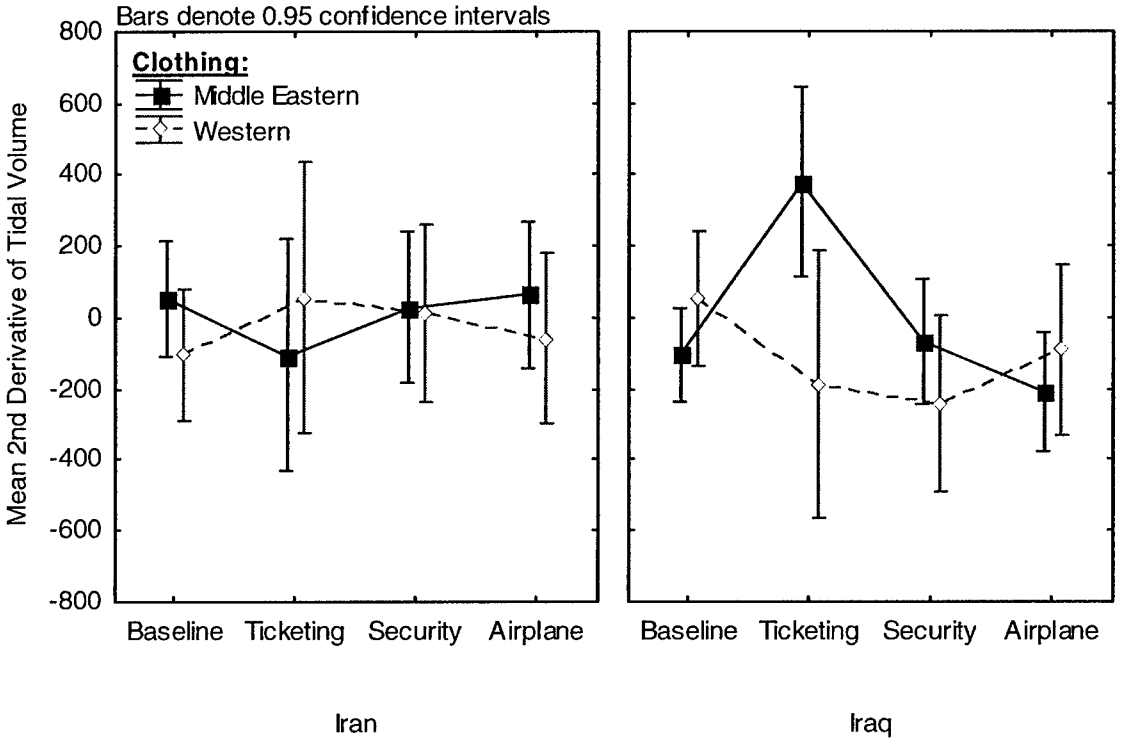

Figure 29. For Iranians, there were no significant differences in the 2nd derivative of tidal volume between the 2 costume groups. However, Iraqis experienced a larger increase at ticketing when wearing Middle Eastern costumes (repeated measures ANOVA; df = 3, 36; p = 0.009).

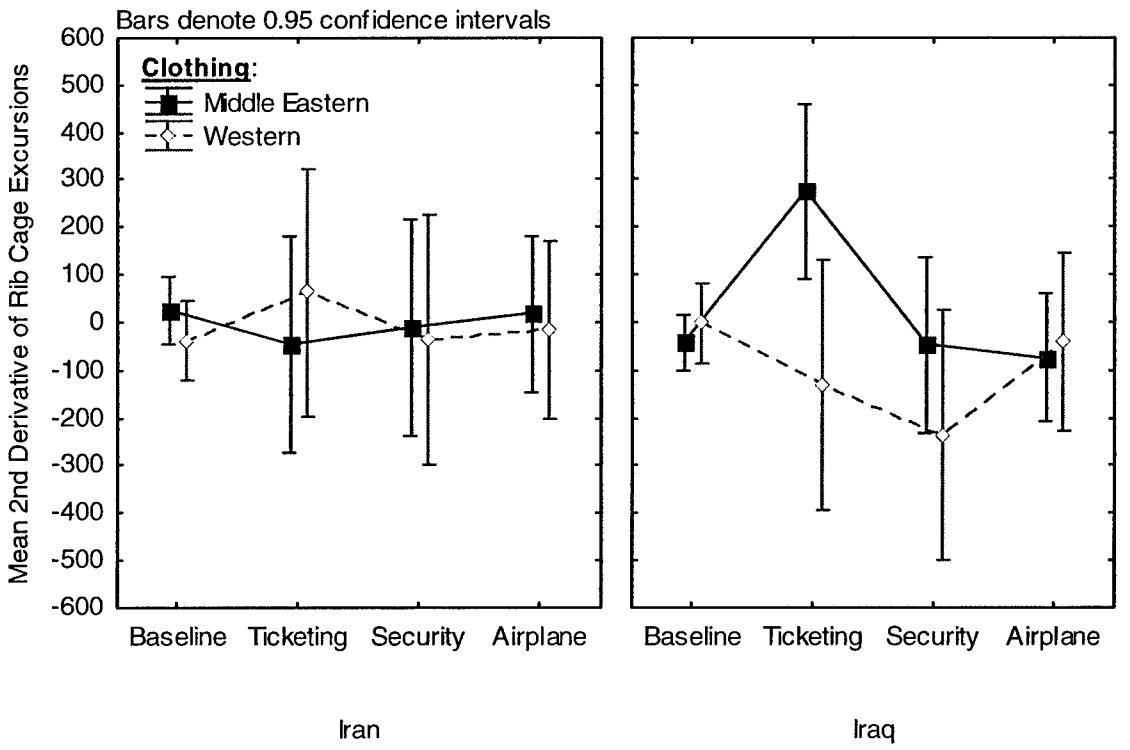

Figure 30. For Iranians, there were no significant differences in the 2nd derivative of rib cage excursions between the two costume groups. However, Iraqis experienced a larger increase at ticketing when wearing Middle Eastern costumes (repeated measures ANOVA; df = 3, 36; p = 0.046).

Muslims vs. Non-Muslims

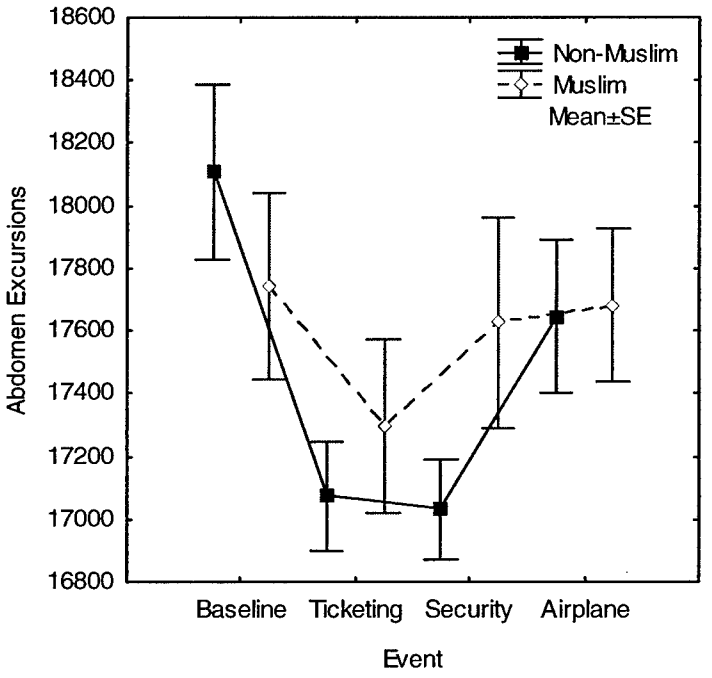

Figure 31. Non-Muslims had a larger decrease in abdomen excursions from baseline, but it was not significant at a 0.05 alpha level (df = 3, 36; p = 0.056).

Security Guard

Guards' Physiology Before and During Questioning

Physiological measures before and during the period when the guard questioned the participant were compared with paired t-tests. The following measures increased from pre-questioning to questioning: heart rate (Figure 32), expiratory tidal volume (Figure 33), expiratory time (Figure 34), respiratory sinus arrhythmia magnitude (Figure35). The following measures decreased: breaths per minute (Figure 36), RR interval (Figure 37), abdomen excursions (Figure 38).

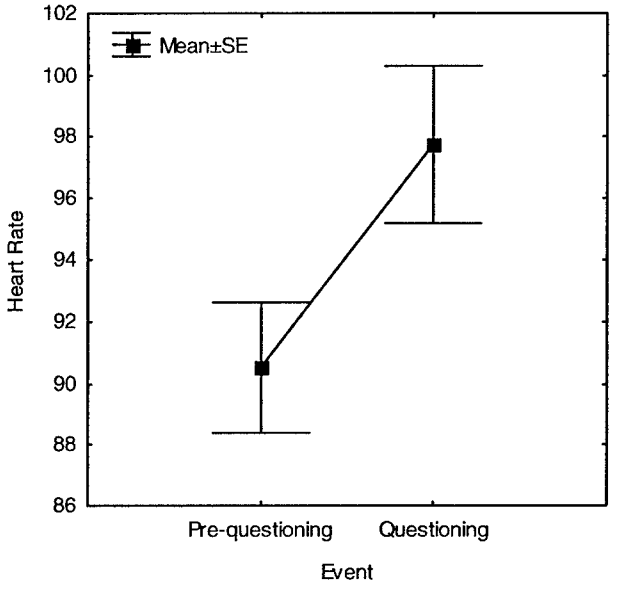

Figure 32. The security guards' heart rates increased during questioning suggesting increased anxiety (df = 28; $p < 0.001$).

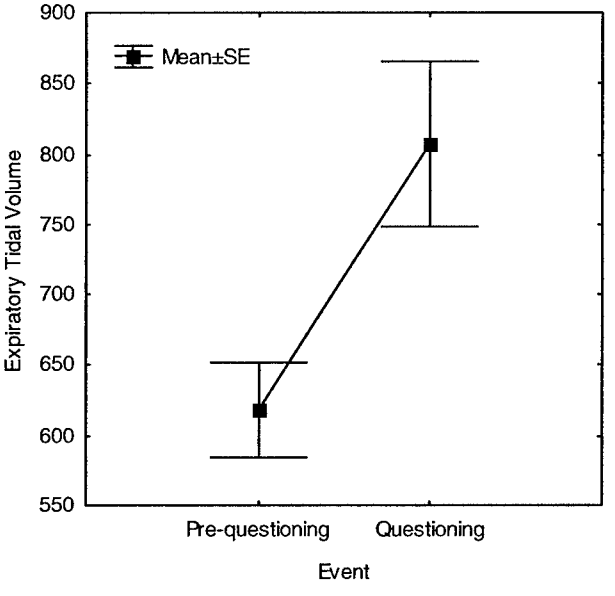

Figure 33. Expiratory tidal volume increased during questioning (df = 29; $p < 0.001$).

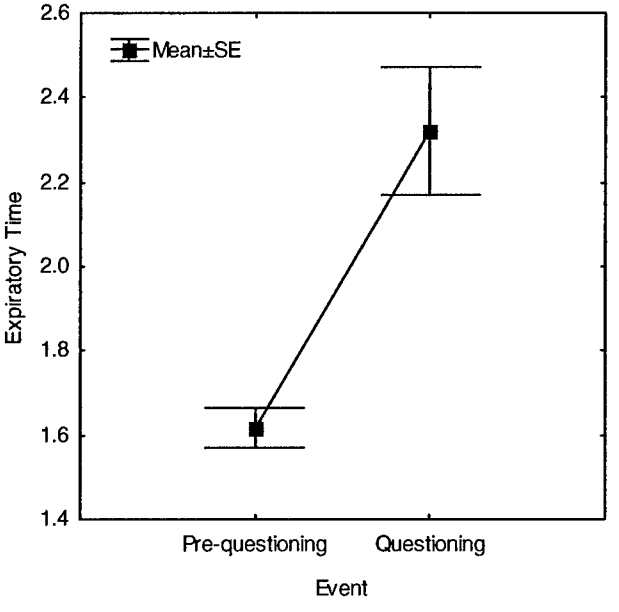

Figure 34. Guards had longer expiratory times during questioning (df = 28; $p < 0.001$).

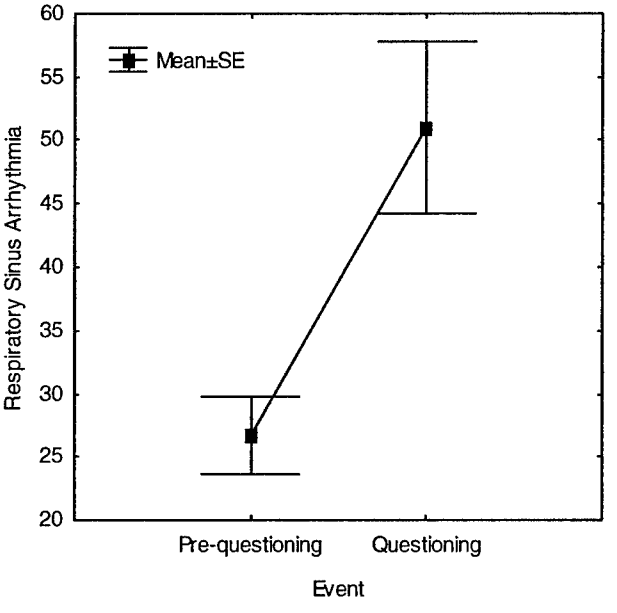

Figure 35. Respiratory sinus arrhythmia magnitude increased during questioning (df = 23; $p = 0.002$).

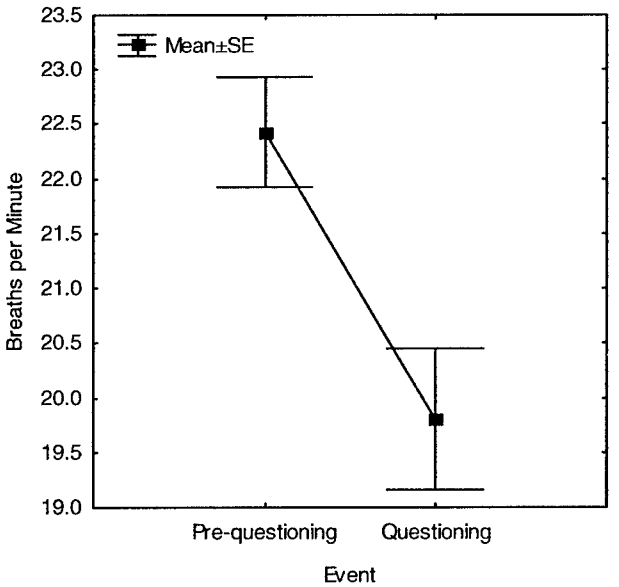

Figure 36. Breathing rate decreased during questioning (df = 29; p < 0.001), suggesting less anxiety

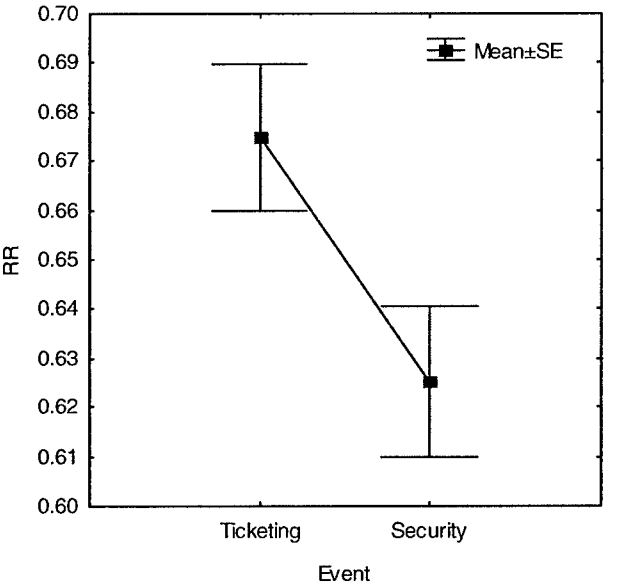

Figure 37. RR interval decreased during questioning (df = 28; p < 0.001). This suggests that the guards' were more anxious during questioning.

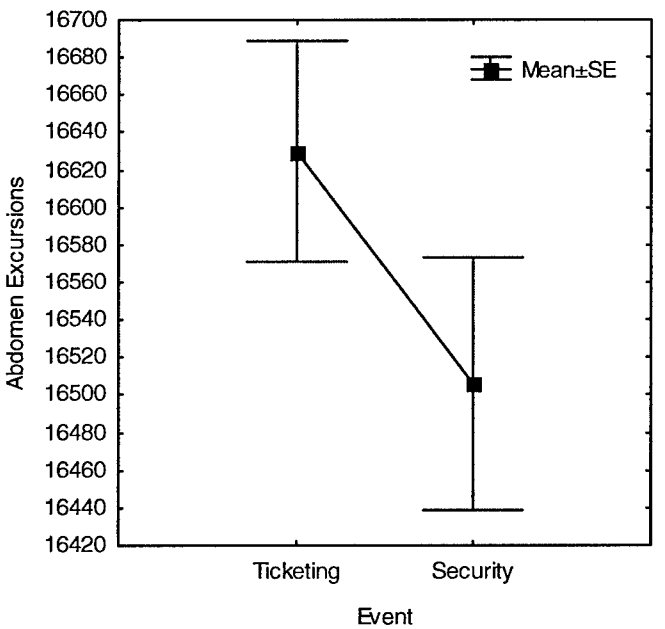

Figure 38. Abdomen excursions decreased during questioning (df = 29; p = 0.017).

Did guards react differently when participants had guns?
There were no significant differences.

Guard Reaction to Asian vs. Middle Eastern

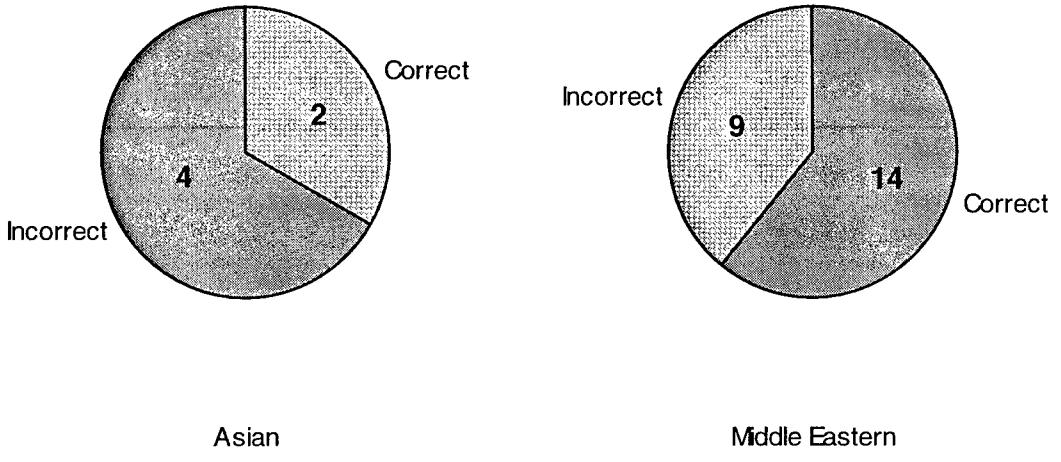

Figure 39. Guards correctly assessed whether a participant was carrying a gun more frequently with the Middle Eastern participants than with the Asian participants.

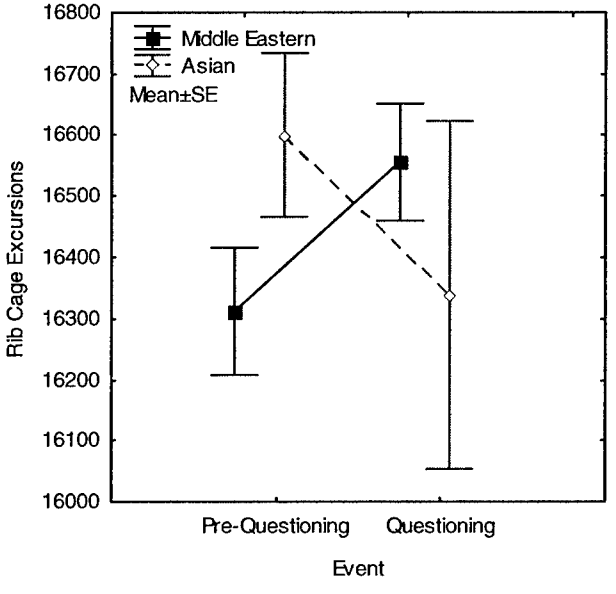

Figure 40. The guards' rib cage excursions decreased when questioning Asians but increased when questioning Middle Easterners (repeated measures ANOVA; df = 1, 28; p = 0.004).

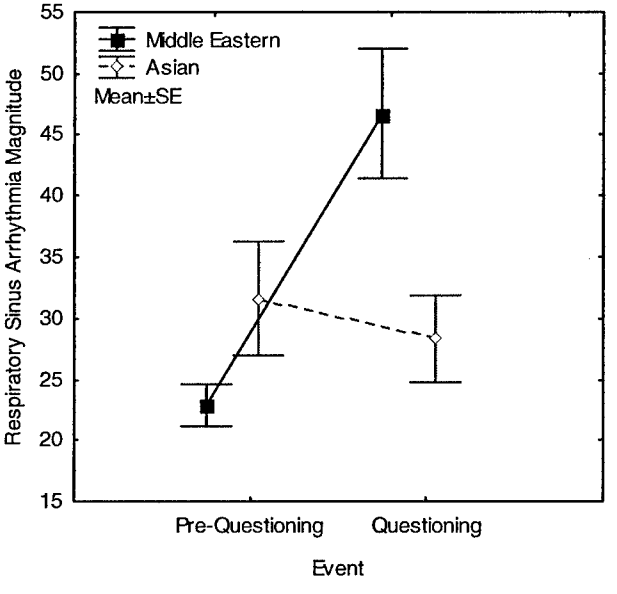

Figure 41. The guards' respiratory sinus arrhythmia magnitudes increased when questioning Middle Easterners but not Asians (repeated measures ANOVA; df = 1, 22; p = 0.012).

Guard Reaction to Middle Eastern vs. Western Clothing

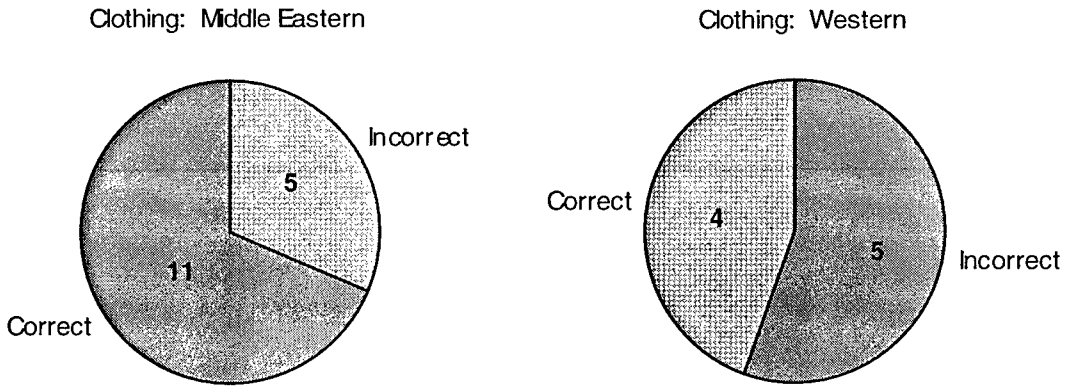

Figure 42. Guards correctly assessed whether a participant was carrying a gun more frequently when the participant was wearing Middle Eastern clothing than when they were wearing Western clothing.

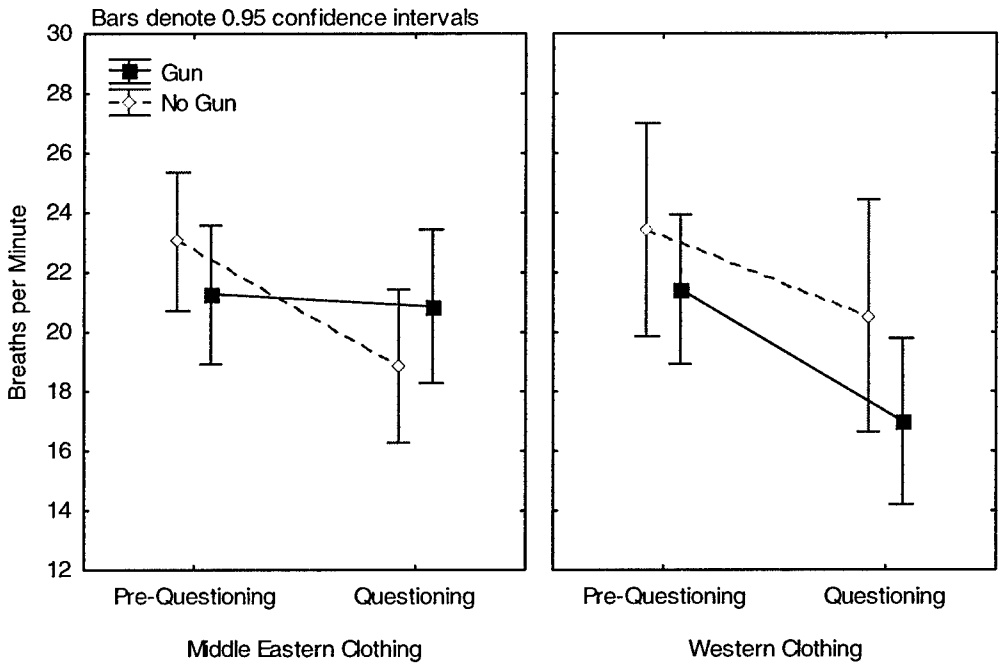

Figure 43. Guards' breathing rates decreased when questioning all participants in Western clothing. However, when questioning participants in Middle Eastern clothes, breathing rate decreased for the "no gun" group but did not change for the "gun" group (repeated measures ANOVA; df = 1,19; p = 0.050). This suggests that the guards were more relaxed when questioning all participants except the ones wearing Middle Eastern clothing and carrying guns.

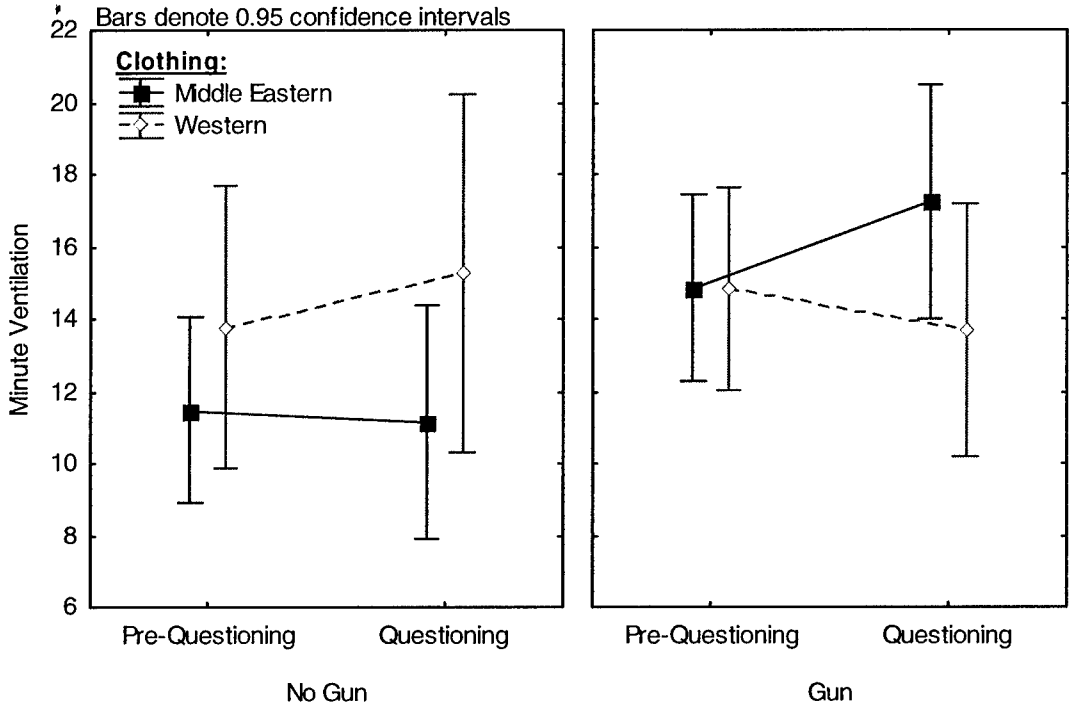

Figure 44. For each of the 2 gun groups, the guards' minute ventilation changed in opposite directions depending on the participants' clothing (repeated measures ANOVA; df = 1,19; p = 0.012). When questioning participants without a gun, it increased when they were wearing Western clothing and decreased slightly when they were wearing Middle Eastern clothing. When questioning participants with a gun, minute ventilation decreased when they were wearing Western clothing and increased when they were wearing Middle Eastern clothing.

Was the guard's physiology different when he made a correct identification?

There were no significant differences.

Was the guard's physiology different when he made a correct identification with 100% certainty?

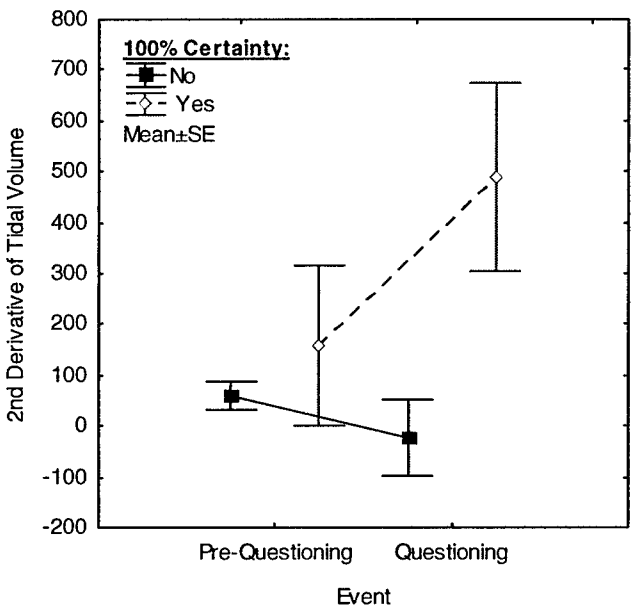

Figure 45. The 2nd derivative of tidal volume increased when the guard was 100% certain that the participant had a gun, but for all other trials there was a small decrease (repeated measures ANOVA; df = 1,25; p = 0.025). There were no instances of the guard being 100% certain that the participant did *not* have a gun.

Gun vs. No-gun Participants

How did carrying a gun and lying to airport personnel affect the participants' physiology?

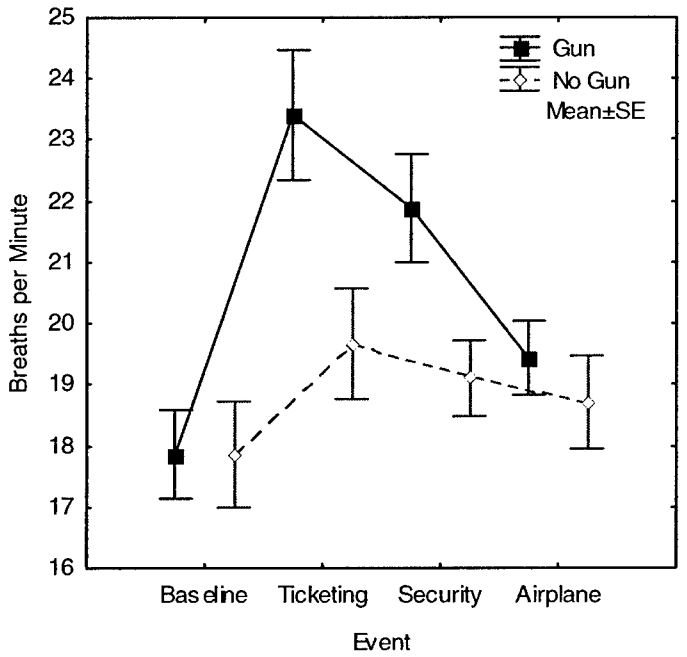

Figure 46. Participants with a gun experienced a larger increase in breathing rate from baseline than participants without a gun (repeated measures ANOVA; df = 3, 69; p = 0.007). This suggests that participants with a gun felt more anxious in the airport.

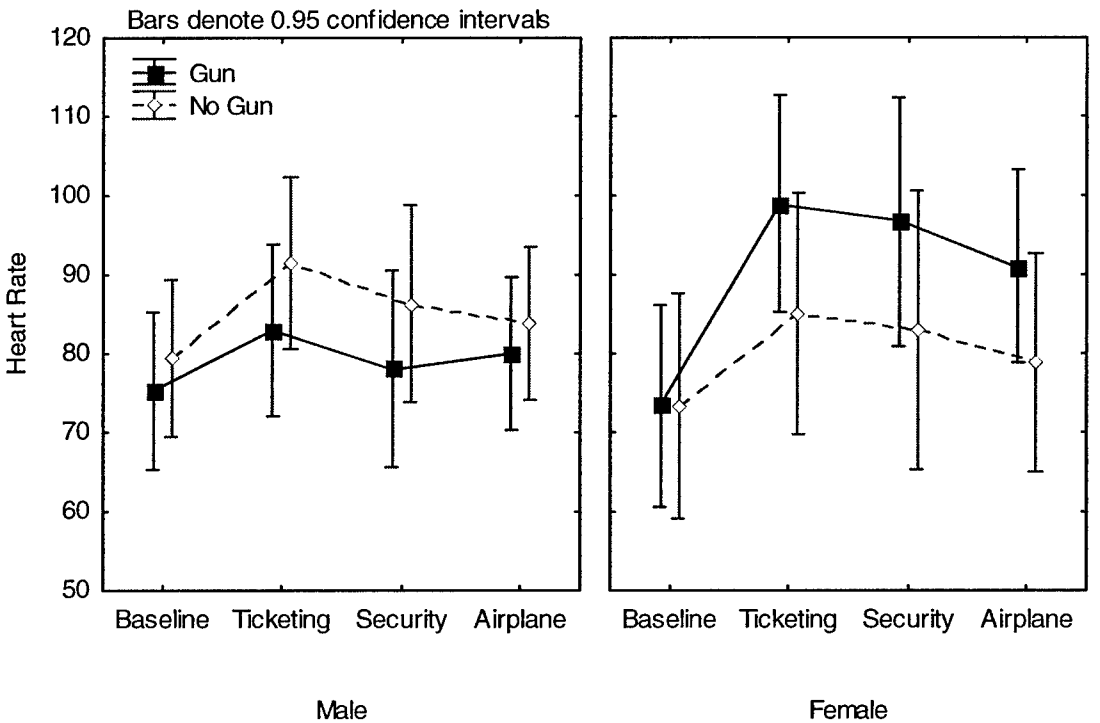

Figure 47. Women had a larger heart rate increase in the airport when they had a gun, but men did not differ significantly between the gun groups (repeated measures ANOVA; df = 3, 63; p = 0.029). This suggests that while men did not react differently to the two gun conditions, women were more anxious in the airport when they had a gun.

Discussion

1. VR VS Live

A. Similarities (Figures 10-14)

In this part of the study we wanted to understand whether or not the virtual space could substitute for the real world place in deception experiments. The graphical quality of the virtual airport showed very high fidelity with good pixel resolution.

The results shown in Figures 10-14 specifically measured physiological responses while in the virtual and real airports. Overall, the results indicated that physiological responses were similar in both the virtual and real airports. Subjects did report higher levels of anxiety during the real airport part of the study. Nonetheless, similar types of physiological responses were seen. Other specific cultural differences were noted. In general, Asians exhibited higher levels of anxiety, as manifested by decreases in skin temperature than Middle Easterners (Figures 10 and 11). In general, the highest level of physiological arousal was noted at the ticketing agent's station, which probably indicates a high level of arousal to this unique situation. What is interesting, though, is that a similar high level of arousal was seen in the virtual environment. Therefore, again, we see the virtual environment as an excellent tool that can be used to predict behavior in a real environment.

B. Differences (Figures 15 and 16)

When we look at the heart rate in the virtual vs. the live experiments, the magnitude of the heart rate increase was much greater in the live environment. A similar pattern of responses, however, was seen in the virtual environment (Figure 15). In Figure 16, looking at the VR vs. Live differences, when participants did not carry a gun through the scenario, there are essentially no differences in breaths per minute. When looking at the group which carried the gun, we see the expected increase in breaths per minute, indicating increased anxiety in the live experiment. For some reason, in the virtual environment, there was a decreased breathes per minute. We have analyzed the data several times, and do not yet have an explanation for these differences. These may be important differences that need to be investigated further, or we need to run more subjects to see if this potential difference is repeatable.

2. Cultural Differences

A. Asians VS. Middle Easterners (Figures 17-20)

Figure 17 shows that there were no differences in gender when subjects navigated the virtual airport. Asian males, however, showed an increase in the HF band, indicating higher levels of anxiety. This finding correlates with the temperature drop seen in Asians in the previous experiment. In Figures 18-20, we see similar indicators of higher levels of anxiety in Asians as compared to Middle Easterners. In these three Figures, gender differences were not noted. Figures 18-20 reflect experiments in the live airport, again showing similar physiological responses in the virtual and live scenarios. The virtual airport may be a useful tool for evaluating and predicting a variety of cultural responses to potential security threats.

B. Iraqi VS. Iranian (Figures 21-24)
VR VS. Live

Figures 21-23 show that Iranians and Iraqis had essentially opposite physiological responses to the virtual airport. These findings support some of our earlier studies, where we documented marked cultural differences in response to virtual environments. The data may indicate that the Iraqis showed more anxiety than the Iranians in the virtual environment. (We did a study on Muslim vs. non-Muslim differences, but no significant findings were noted—to be discussed later). In Figure 24, we see that the Iranians did not show significant physiological change when carrying a gun through the real airport, however, Iraqis showed changes in abdominal excursions, which can be correlated to an altered breathing pattern. These data suggest that Iranians may be able to conceal a weapon more effectively than Iraqis.

C. Middle Eastern VS. Western Clothing (Figures 25-30)

Figures 25-30 show physiological responses when participants wore either Western vs. Middle Eastern clothing in the real airport scenario. From Figure 25, we note that, overall, participants seemed more anxious while wearing Middle Eastern clothing. This probably reflects the fact that most of the participants wear Western-type clothing in their everyday life. In

addition, most Iranians wear Western clothing even in Iran (males only). Figure 26 and 27 suggest that women, when dressed in Western clothing, had higher levels of anxiety than in Middle Eastern clothing. This may reflect more covering from the Middle Eastern clothing and hence more comfort. From Figure 29 and 30, we again note that Iranians did not show significant differences when wearing either type of clothing, whereas Iraqis had a higher level of physiological response. Overall, we see that Iranian participants in general did not exhibit significant changes in physiological responses, which indicates that the search for deception cues may require analysis of more subtle differences.

D. Muslim VS. Non-Muslim (Figure 31)

We attempted to ascertain whether there were any differences in Muslims vs. non-Muslims, however, we did not find any significant physiological differences, probably reflecting too small of a sample size and too much variability and heterogeneity in this group.

3. Security Guard

A. Physiological Monitoring (Figures 32-38)

Overall, these experiments show that the security guards had higher levels of physiological arousal during questioning as compared to baseline. We need to more carefully understand the physiological responses of security personnel, so that we can more fully and carefully evaluate optimal training programs that produce effective deterrent.

Guard Reaction to Different Cultures

Figure 39, although not statistically significant, showed that the guard more accurately determined who was carrying a gun in the Middle Eastern participants than in the Asian participants. Part of our intent, in this part of the study, was to try to correlate objective physiological responses to accurate determination of possible hostile threats. Figures 40 and 41 show that the guards had higher levels of anxiety when questioning Middle Easterners vs. Asians. These differences were seen regardless of Western or Middle Eastern dress. These differences may reflect a cultural bias in the guards. Figure 42 shows that, although not statistically significant, the guards were more accurate in determining who was carrying a gun when the participants wore Middle Eastern clothing. However, Figure 43 shows that when participants wore Middle Eastern clothing and were carrying a gun, the guards did show a modest physiological difference. This difference needs to be investigated further, because making the guards aware of subtle physiological responses might help objectify hunches or gut feelings. Figure 44 shows a similar finding. We were unsuccessful in determining an objective marker for correctly guessing who is carrying a gun and who wasn't carrying a gun; however, Figures 43 and 44 suggest that we need to conduct additional experiments with larger numbers of interrogators. The ultimate goal of these types of studies is to more effectively train security personnel in recognizing deceptive behavior.

B. Guard Certainty (Figures 45)

In this experiment, we wanted to determine whether or not there were any objective physiological markers when the guards felt 100% certain that the participants were carrying a gun. These experiments grew from discussions with security guards who often told us they were 100% certain that certain participants were carrying a gun. Their "certainty" was based on their observations, years of experience, and "gut feelings." Although there was a significant difference in second derivative of tidal volume, no other physiological correlates could be found. Tidal volume relates to breathing rates which are influenced by levels of anxiety. Often, changes in breathing reflect unconscious fears or anxiety. We need to further investigate whether there is any way to correlate objectively these feelings of "certainty" which are often based on poorly-defined criteria and street smarts.

C. Gun/No Gun (Figures 46-47)

Figure 46 shows that higher levels of anxiety were exhibited in the real airport when participants carried a gun, suggesting that targeted noninvasive sensing may pick up significant numbers of hostile threats. Figure 47 showed that there were gender differences in that women had higher levels of anxiety while carrying a gun vs. men.

Summary

- There are substantial physiological and cultural differences between the responses of Asians and Middle Easterners.
- VR elicits similar physiological responses as seen in the real world, thus VR is a good tool for investigating cultural influences and deception.
- Iranians show muted or decreased physiological responses to challenges and events.
  - Iranian men's physiology does not change when dressed in Middle Eastern or Western garb (see Figure 20).
  - Iranian physiology does not change even when carrying a gun (see Figure 24).
  - Iranians may be more adept at deception.
  - Iranian Shiite Muslims carry no internal guilt thus it is more difficult to detect deception within that group compared to other Arabs and Middle Eastern Muslims.
- Middle Easterners elicit the most significant physiological changes in the anticipation phase (ticketing) of the airport evolution (see Figures 10-15).
- There may be a cultural issue with Middle Eastern women dressed in western clothing (see Figure 26). One explanation may be that they feel uncomfortable and inappropriately dressed when dealing with an authority figure. For example, many Middle Eastern women change their clothing on the airplane when traveling from Europe or the USA back to the Middle East. There may be an issue of sham when challenged by authority.
- Security agents seem to have a bias to Middle Eastern clothing (Figure 35). However dressing the subjects in different types of clothing is a very important tool for training.
- Measuring the physiology of the interrogator and the interrogated clearly requires further research. This interaction is so similar to a physiological therapy session as to beg further investigation.

Future Plans

It is clear that cultural differences are important in uncovering deception and deceptive actions. Middle Eastern behavior is different than Asian behavior. Further, Iranian responses are different than Iraqi responses. Iranians show a paucity of physiological changes when presented with a variety of challenges. We would like to uncover how Iranians nonverbally communicate deception to each other in their own cultural context. Once we understand these subtle forms of communication we can begin to anticipate behaviors and responses and then challenge them with the appropriate actions.

We would also like an opportunity to look at Asian Muslims from Singapore, Philippines, and Indonesia and compare them to Middle Eastern Muslims to see whether religion or culture will predominate in the study of deceptive behavior. In addition further study of individual Asian cultures (Chinese, Korean, and Japanese) is necessary.

Itemized Man-Hours and Costs
Direct Labor: $133,345
Direct Materials: $125
Other Direct: $5,653
Indirect Costs: $104,521
Total: $243,644

Contract Deliveries Status
Annual Technical Report sent ninety days after the end of the year

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